

**FROM MARVEL TO SCIENCE FICTION
INTELLECTUAL AND LITERARY HISTORY OF INSECTS**

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DECLARATION

I declare that the entire work now submitted as a thesis for the Degree of Master in the University of Hawai'i at Manoa is the result of my own independent research and is wholly my own composition.

I further declare that this thesis has not already been presented in substance for another degree in this or any other university.

TRANSLATION NOTE

Unless otherwise noted, all translations from French to English are my own.

LIST OF FIGURES

Figure 1: Genealogical tree in the <i>Encyclopédie</i>	68
Figure 2: <i>Système figuré des connaissances humaines</i> in the <i>Encyclopédie</i>	69
Figure 3: main page of the website of L'Arbre des possibles presented via a spiderweb.	74
Figure 4: Close up on one of the tree's branches.....	75
Figure 5: A representation of L'Arbre des possible (here called La Carte des possibles)	76
Figure 6: Werber, Bernard, et al. <i>Science/Fiction voyage au coeur du vivant</i>	93
Figure 7: Werber, Bernard, et al. <i>Science/Fiction voyage au coeur du vivant</i>	94
Figure 8: Nantes' <i>Grand Elephant</i>	98
Figure 9: The Heron in the <i>Galerie des Machines</i>	99
Figure 10: The Caterpillar in the <i>Galerie des Machines</i>	100
Figure 11: The Spider in the <i>Galerie des Machines</i>	100
Figure 12: The Ant in the <i>Galerie des Machines</i>	101

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*Entre
Ce que je pense
Ce que je veux dire
Ce que je crois dire
Ce que je dis
Ce que vous avez envie d'entendre
Ce que vous croyez entendre
Ce que vous entendez
Ce que vous avez envie de comprendre
Ce que vous croyez comprendre
Ce que vous comprenez
Il y a dix possibilités qu'on ait des difficultés à communiquer.
Mais essayons quand même ...¹*

TABLE OF CONTENTS

¹ Werber, Bernard. *Nouvelle Encyclopédie Du Savoir Relatif Et Absolu*. Librairie Générale Française, 2011. P. 1 [Between: What I think, What I want to say, What I believe I said, What I do say, What you want to hear, What you think you have heard, What you actually hear, What you want to understand, What you think you understood, What you actually understand, There are ten possibilities of having trouble communicating. But let's try anyway ...]

DECLARATION – TRANSLATION NOTE	ii
LISTE OF FIGURES	iii
ACKNOWLEDGEMENTS	iv
INTRODUCTION	1
PART I – OBSERVING THROUGH THE IMAGINATION	8
Introduction	8
The ‘emblematic world view’	10
Naturalists and the pursuit of truth through the rise of new technologies	14
Insects, or the product of marvel, fiction and imagination	19
The power of hypotheses, or how to reconcile two poles apart worlds	24
What about the twenty-first century?	28
ZOOPHYTES, INSECTS, AND THE MATERIALIST CHALLENGE TO THE GREAT	
CHAIN OF BEING.....	36
Introduction	36
Lovejoy’s <i>The Great Chain of Being</i> put in perspective through Réaumur’s thoughts	38
The original principles in Aristotle’s <i>History of Animals</i> and the idea of zoophytes	43
Diderot’s materialism in <i>Le Rêve de d’Alembert</i>	47
The polyp in <i>Le Rêve de d’Alembert</i> , a tiny creature with great implications	51
Michelet, or a continuity of the Great Chain of Being	56
Science fiction and Werber	60
PART III – PERSPECTIVE(S).....	65
<i>L’Arbre des possibles</i> (The Tree of Possible Futures)	65
Pascals’s <i>deux infinis</i>	80

Bernard Werber, or the continuity of the Enlightenment	84
CONCLUSION WERBER, VERNE, AND NANTES	91
BIBLIOGRAPHY	104
WEBOGRAPHY	108

INTRODUCTION

“Une fourmi de dix-huit mètres
 Avec un chapeau sur la tête
 Ça n'existe pas, ça n'existe pas
 Une fourmi traînant un char
 Plein de pingouins et de canards
 Ça n'existe pas, ça n'existe pas
 Une fourmi parlant français
 Parlant latin et javanais
 Ça n'existe pas, ça n'existe pas
 Et pourquoi... pourquoi pas”

“A 59-foot ant
 With a hat on its head
 It does not exist, it does not exist
 An ant dragging a chariot
 Full of penguins and ducks
 It does not exist, it does not exist
 An ant speaking French
 Speaking Latin and Javanese
 It does not exist, it does not exist
 And why...why not”

When Vladimir Nabokov, as a lecturer at Cornell University, asked his students how many butterflies there were in Flaubert's *Madame Bovary*, not only did he imply that details in novels are what makes them rich and sublime, he also brought up the importance of what might seem anodyne in literature: insects. Insects have always been a part of fiction, and their presence in literature – far from being trivial – is a key component of literature. In the same way, when Robert Desnos wrote the above poem about a fictional ant that speaks Javanese while wearing a hat and dragging penguins in a chariot, he did so because ants are so common in people's everyday life that they become poetical. Everyone has feared that dreadful mosquito sound at night, everyone has been bothered by a bee or a wasp during summer time, everyone has been mesmerized by the beauty of butterflies, and this ordinariness verging on poetic is also reflected in novels: insects are teeming in the natural world as well as in literature.

However, insects in literature are not always used as a mere description to give life to a scene. Insects are also a source of deep philosophical questions, all the more so when considering literature on insects from past centuries. They have always been a source of scientific fascination, and their smallness has frightened and puzzled naturalists, scientists, and authors. Since knowing something that small was almost impossible before the invention of the

microscope, the unknown became a part of the definition of insects. And yet, even today with ultra-sophisticated microscopes, something is missing in the understanding of insects, that is, scientific observation is still supplemented with poetic imagination and invention.

In this regard, this thesis, entitled “From Marvel to Science Fiction: Intellectual and Literary History of Insects,” aims to compare contemporary science fiction author Bernard Werber, especially his first novel *Les Fourmis* [*The Empire of the Ants*], to texts written by naturalists from the long Early Modern period. By “Intellectual History,” I want to express the ideas and concepts that surrounded the study of insects and, more generally, the study of the natural world. By reading a text in the context in which it was written, particularly the scientific context, explains certain notions and definitions that are understood in a whole new way today.² By “Literary History,” I mean that this thesis aims to trace the discourse used to talk about insects in literature in a wide definition of the term. Indeed, this thesis uses past texts that we might not necessarily consider literary, but this approach highlight the importance of crossing disciplines in order to better understand contemporary science fiction. In short, going back to the tradition of Enlightenment entomologists sheds new light on the understanding of modern texts. By drawing from philosophy, natural sciences, and history, this thesis analyzes how insects were understood and portrayed in literary ways, and how observation, technology, and fiction were linked through discourse. Reading scientific texts through a literary eye indeed allows navigation between the two fields, and an expansion of the corpus that can be used to understand the relationship between entomology and literature.

Before going any further, it is important to explain the genesis of this thesis. Born and raised in Toulouse, France, Werber has always been interested in story making and fiction. After

² I unfortunately could not elaborate on the nineteenth century scientific context, namely the birth of modern biology with Lamarck and Darwin’s *On the Origins of Species*. The intellectual context on the nineteenth century is therefore not developed in this thesis.

his baccalaureat, he started to write his first draft for what will become *The Empire of the Ants*. After studying criminology in Toulouse, as well as journalism in Paris, he decided to settle there and started working for the newspaper *Le nouvel observateur* as a science journalist. After twelve years of working on many different drafts, and after many failures, Albin Michel—a publisher who had previously refused his draft—accepted his manuscript. Since then, Werber writes one book a year, each of them being published in October. Werber is a sort of contemporary humanistic spirit from the sixteenth century who tries to erase the boundaries between disciplines: everything interests him from mythology, to the natural world through the imaginary the afterlife. This humanistic spirit is also shown in the medium he uses: painting, comic books, novels, movies, theater, writing classes, and a personal website.³

His very first novel *The Empire of the Ants* intertwines two different stories from two different points of view: one in the world of humans, the other in the world of ants. The human characters, Jonathan, his wife Lucie, and their child Nicolas, receive a house as inheritance from the deceased uncle Edmond Wells, as well as a tempting message stating to never go down the cave. Intrigued by this message, and looking for a purpose for his life, Jonathan decides to disobey, and never comes back; leading his family to follow him, and disappear as well. In the ants' world, an ant investigates the death of a foraging expedition that died without leaving any traces. In her search of a potential secret weapon used by another colony, the ant attracts the attention of a group of ants “the smells like rock” within its colony that appear to want to conceal this information. As the story unfolds, the reader learns that the humans and the ants have been in communication, and that this is that communication between two different species that needs to be concealed, as neither world are ready for such an important scientific discovery.

³ For further information, please find a list of all the radio interviews and newspaper that tackled with Werber and his work on Werber's website, particularly this page dedicated to media: <http://www.bernardwerber.com/medias.php>.

I decided to work on Bernard Werber because I believe that science fiction is under-represented and not studied enough in French Literature. Being one of the most well-sold authors of French literature in France and abroad, even considered a ‘superstar’ in Russia and Korea, one could expect to see a lot of scholarship on him. Surprisingly, only a few scholars attempted to analyze his works; for instance Gilbert Millet’s *Etudes sur les Fourmis – Bernard Werber* and Elaine Després’s Master’s thesis *Encyclopédie, encyclopédisme et bibliothèque totale : la gestion des savoirs chez Jorge Luis Borges, Isaac Asimov et Bernard Werber*. In order to show the relevance of Werber works, but in a greater scheme, the importance of science fiction; this thesis aims to understand where Werber comes from by studying the literary lineage from which he emerged.

This thesis then compares texts and ideas from the sixteenth century to the modern day. The scope of this thesis is broad and does not focus on one single century in depth. However, taking into account texts from such a wide time frame allows for the observation of a progression of ideas and concepts surrounding insects in literature: it shows how contemporary authors sometimes use past ideas in a new way. Texts by Réaumur, Diderot, Michelet, and Werber are compared to examine how the wonder surrounding insects was used, making insects into a lens through which to talk about concepts regarding humankind and the natural world, for instance, the idea of the Great Chain of Being and of the philosophical concept of perspective.

Because of a time constraint, I was not able to expand my corpus to other authors who are also related to literature and the field of entomology; for instance Jan Swammerdam, Ulisse Aldrovandi, Pierre André Latreille or Jean-Henri Fabre. Even though most of them are mentioned in this thesis, I decided to focus particularly on one entomologist per century that, I believe, is a good representation of the field in his respective century. I therefore chose Réaumur,

specifically his *Mémoire pour servir à l'histoire des insectes*, because of the interesting point of view he brings to the study of insects, particularly the definition he gives of them in the introduction of his *Mémoire* that will be developed further in chapter two. The nineteenth century entomologist I chose is the historian Michelet: even though his work on insects represent but only a small fraction of his entire corpus, he nevertheless tackles with a very important concept that is a common theme to all the authors studied. When Michelet wrote *L'Amour or La Femme*, he was trying to find out more about himself, and more generally, about what it is to a human. In *L'Insecte*, Michelet is looking an answer to this question: do insects, animals, and ourselves, have a soul? This will be more developped in chapter two as well.

In order attain better understand the new definitions of insects brought up Réaumur, this idea of “l'âme des bêtes” [the soul of beasts], and other concepts related to entomology in literature, critical sources by Wilda Anderson or William B. Ashworth, among others, are used to explain ideas that share a common ground with insects. Anderson helps framing ideas about Diderot's material paradigm, and helps explaining his ideas on the polyp in *Le Rêve de d'Alembert*. Ashworth explains the Renaissance understanding of the cosmos, which proves helpful when reading texts from the Enlightenment and the modern day. Since this thesis is interdisciplinary, a greater overarching argument regarding the crossroads of science and literature is analyzed through Michel Foucault's essays and Snow's notion of the ‘Two Cultures.’ Snow claimed that science and literature grew apart as the centuries went by, but this thesis argues the contrary, claiming that it is still important to consider these two fields as a network of intersecting ideas that cross fields' boundaries.

One quote is particularly relevant in explaining the genesis of this thesis: “Though modern biology can tell us many fascinating things about how the smallest elements of a living

being function, perhaps it cannot tell us everything.”⁴ It is fascinating that even in the twenty-first century, something as small and fragile as an insect resists cutting-edge technology and knowledge, such that there are still unknown parts in the natural world waiting to be discovered and decoded in language. Literature helps to overcome this doubt through the imagination of hypotheses about what may be; and in this regard, fiction becomes part of the understanding of insects, trying to fill the gap between current knowledge and an absolute definition.

The first part of this thesis shows how new observational technologies, particularly the microscope, impacted the study of insects, and therefore influenced the language used to talk about them. Discourse and technology are related in that naturalists now have access to more information; and yet fiction remains a part of these texts as the unknown is still present in the field of entomology. The second chapter discusses how this new discourse on insects impacted taxonomical systems in the eighteenth century. These problems are also traced to modern authors who have inherited this complex understanding of insects as being more than ‘only’ insects. Insects are portals through which authors and scientists can ponder greater ideas and concepts; they become an emblem that represents something that transcends the image of an insect. By thinking of an insect as something greater than it is, their ‘place’ in the natural world is modified and challenge, once again, the definition of what insects are. The third and final chapter argues that the smallness of insects urges naturalists, scientists, and observers in general to think about the world in perspective. Perspective, which is at first a mathematical and geometrical tool, was used by philosophers to situate humankind in the greater universe. It was also used by naturalists to express the relativity of species to one another, and was then used in literature in the form of hypotheses to imagine the future, that is, to see humankind from a larger perspective.

⁴ Susannah Gibson, *Animal, Vegetable, Mineral?: How Eighteenth-century Science Disrupted the Natural Order* (Oxford: Oxford University Press, 2015), 186.

Finally, the conclusion shows how today's engineers are creating insects that will be part of a greater urban project, the *Arbre aux Hérons*. This tree, when it opens in 2020, will be a materialization of ideas and concepts studied in this thesis as it will challenge people's definition of insects and their understanding of the natural world.

OBSERVING THROUGH IMAGINATION

“N’importe quelle personne qui observe la nature et qui s’émerveille devant la nature quelque part est un scientifique. En fait, plutôt que de parler de science, on devrait parler plutôt d’observation et de compréhension de l’univers.”⁵

1) Introduction

The way in which the naturalists and scientists have observed the natural world – and therefore the way they perceived it – has always been intertwined with the technologies that were available to them in their time. As a twenty-first-century reader or scientist, this idea might be hard to grasp, as people have grown accustomed to modern technologies and information available in a glimpse of an eye. However, the way we understand and think about the world nowadays is utterly different than how it used to be a few centuries ago: today, telescopes see further, and microscopes see closer. Seventeenth-century naturalists and philosophers had to rely on a different set of tools in order to understand the world that surrounded them – using their physical senses in order to comprehend their world, and reading the works of ancient naturalists whose knowledge and authority they sought to emulate.⁶ When the study of insects blossomed in the seventeenth century, and for as long as observational inquiry has been a part of humanity’s understanding of the world, it is worth wondering: What was considered true scientific knowledge? What does it mean to use technology? What did observation mean, and what was

⁵ “Science/fiction : voyage au Coeur du vivant” Bernard Werber Site Officiel. N.p. 2010. www.bernardwerber.com/videos/videos.php?id=92&selection=bw, 7 Sept 2017. [Anyone who observes nature and marvels at nature is in some sense a scientist. In fact, instead of talking about scientists, we should talk about observation and the understanding of the world].

⁶ For more information, see Brian P. Copenhaver, “Natural Magic, hermetism, and occultism in early modern science,” *Reappraisals of the Scientific Revolution* (Cambridge University Press, 1990). For instance, he states “The main inspirations of Polydore’s *De inventoribus rerum* were ancient literary and historical sources. (267)

the relevant epistemological framework from which to observe the world? How was knowledge organized, and what were the taxonomical boundaries of the observed time? Finally, are these questions still relevant today, and have the answers changed since then?

Asking these questions leads to an understanding of how their answers changed from the sixteenth century to the present. Through these questions, I aim to show how the idea of fiction and entomology are intrinsically related.⁷ The idea of what an insect is in Western civilization has changed over time: naturalists have studied insects, but the field of entomology blossomed around the beginning of the eighteenth century, changing the way that the natural world was perceived. Even though the study of insects has now become an easier task with new technologies, many questions remain unanswered and insects are still surrounded with wonder. Even though entomology and its development over time helped demystify the insect world, both scientific literature and literary works still leave room for mystery. Early naturalists, through observation, deduction, and assumption, attempted to fill gaps in knowledge in order to grasp the full idea of the insect world and yet – even today – fiction is used to imagine their life and to fill voids not accessible by scientific thought. Even more, through literature and specifically through fiction, insects are commonly used as a metaphor and literary tool to depict and understand the human world.

2) The ‘emblematic world view’

⁷ Using the word entomology before 1745 is somewhat of an anachronism. It is the Enlightenment naturalist Charles Bonnet who used it first: he did not like the word entomology, and preferred the term insectology instead, as stated in his *Contemplation de la Nature* (1745): “j’ai donné le nom d’insectologie à cette partie de l’histoire naturelle qui a les insectes pour objet. Celui d’entomologie (...) m’a effrayé” [I entitled ‘insectology’ the portion of natural history that deals with insects. The word entomology (...) scared me]. Therefore, the term “study of insect” will be used when referring to an era pre-Bonnet. (chapter IX p. 426). For the sake of this thesis, I will use the term entomology even for pre-1745 periods.

The dissection of humans and animals helped naturalists obtain a better understanding of how their bodies work. However, it was impossible to properly dissect an insect; something as minuscule as an ant cannot be properly parsed. This did not prevent philosophers and naturalists from using forms of visual observation. For instance, Aristotle talked about insects in the fifth book of *History of Animals*, in which he tackled the idea of reproduction in the animal and human kingdoms. He stated that “Insects copulate and breed in winter also, that is when the weather is fine and south winds prevail; such, I mean, as do not hibernate, as the fly and the ant,”⁸ a statement that can only be affirmed after close observation of insects. Aesop also wrote about insects, as in his fable *The Bee and Jupiter*⁹ in which he gave an explanation of why bees die once they sting. Once again, Aesop must have directly observed insects – or learned from someone else through reading – to know that bees do die once they sting and lose their stinger.

These observations relied both on the use of physical senses and on the reading of naturalists’ books. However, can one trust everything that is written in ancient sources? Can our senses be trusted? Does scientific observation imply authority? Does information have to be verified through multiple sources and media, or does one trust written knowledge and take it for granted without verification? Does everyone see the natural world the same way, particularly when the object of study is minuscule? When reflecting upon sixteenth-century naturalists, René Antoine Ferchault de Réaumur, an eighteenth-century naturalist (1683-1757), wrote in his *Memoires Pour Servir à L'Histoire Des Insectes* that “On observait alors la nature que pour y voir ce qu’on avait lu dans les anciens.”¹⁰ According to William Ashworth, historians of science

⁸ Aristotle, et al. *History of Animals* Book V (Cambridge, Mass.: 1991).

⁹ Kennedy, Amos Paul, and Aesop. *The Bee and Jupiter: From Aesop's Fables*. Whitewater, WI: Picasshaw, 1993.

¹⁰ René Antoine Ferchault De Réaumur, *Memoires Pour Servir à L'Histoire Des Insectes* (N.p.: n.p., 1734), 29. [Back then, we used to observe the world for the sole purpose of seeing what we read in ancient books].

had long looked down upon the sixteenth century when it came to the comprehension of the natural world because – unlike physical sciences – they did not consider natural history has being a part of the Scientific Revolution.¹¹ The Scientific Revolution relates to the period when physics, mathematics, chemistry, astronomy, and other sciences emerged as a way of understanding the world. Just as Réaumur accused sixteenth-century naturalist of merely copying ancient sources without contributing any new insight, historians blamed naturalists of that Early Modern period (during the Scientific Revolution) for not being pioneers and visionaries in their field. Historians used to believe that natural philosophers of the sixteenth century were not scientists, but in his article, Ashworth gives scientific credit back to these naturalists. He argues that his peers have been looking at this period from a too modern point of view without contextualizing their approach to the history of science, and therefore have not been asking themselves the right questions.¹²

Indeed, the sixteenth century raised many questions regarding the natural world. The modern field of biology was then seen as a “complex web of association that links [any animal] with history, mythology, etymology, the rest of the animal kingdom,”¹³ or, as Ashworth called it, the “emblematic” world view. In order to know and understand something, one must know its “affinities, similitudes and sympathies with the rest of the created world.”¹⁴ In other words, sixteenth-century naturalists saw each being in the natural world as an emblem, a book in which

¹¹ Ashworth, William B. "The Revolution in Natural History." *The Scientific Revolution* (n.d.): 130-56. P.133-134. Ashworth's states: "I believe that our assumptions and conclusions concerning the nature of natural history are seriously flawed and have prevented us from understanding a crucial development in late Renaissance and early seventeenth-century." His goal, in this article, is to "show that the demise of emblematic natural history was a crucial part of the development that we call the Scientific Revolution."

¹² This is close to the idea of re-contextualisation that Quentin Skinner and the 'Cambridge School' developed in the twentieth century. See for instance McMahon, Darrin M., and Samuel Moyn. *Rethinking Modern European Intellectual History*. Oxford University Press, 2014.

¹³ Ibid., p.135.

¹⁴ Ibid.

they could read beyond the visible to define these beings. Naturalists gained knowledge from ancient literary sources, like Pliny, Plutarch, Ovid, or Aristotle, rather than by observing the natural world.¹⁵ According to Ashworth, this emblematic world view was born thanks to the development of six other fields and literary traditions: “hieroglyphic, antiquarian[ism], Aesopian fables, mythology, adages and emblematic traditions,”¹⁶ all of them intertwined. Through these different lenses, the understanding of animals became broader, and evolved to a point where the definition of an animal had to include all possible knowledge regarding that being.

One of the most important naturalist figures participating in this emblematic world view, Ulisse Aldrovandi, published a book in 1602 on insects entitled *De animalibus insectis, cum singulorum iconibus ad viuum expressis*. Aldrovandi wrote hundreds of pages on insects and everything related to them, including known natural knowledge, fables, mythologies, and symbols. Moreover, Aldrovandi’s work included etchings of bees, hives, butterflies and other insects. By placing these etchings in his books, Aldrovandi brought an anatomical and zoological approach to the emblematic world view. According to Brian Ogilvie in his article *Nature’s Bible: Insects in Seventeenth-Century European Art and Science*, “Aldrovandi placed great value on illustrations as a source of knowledge” and therefore, his “woodcuts and verbal description aimed to show what a perceptive observer would see when confronted with the individual specimen.”¹⁷ Aldrovandi was a forerunner in accurately describing insects after closely observing different specimens: he broke with the tradition of observing the world in order to re-observe what ancient naturalists observed. In order to get a full understanding of insects, he worked with a secretary and a painter to render into words and pictures the information he

¹⁵ Ibid., 134-135.

¹⁶ Ibid., 136.

¹⁷ Brian W. Ogilvie, ‘Nature’s Bible: Insects in Seventeenth-Century European Art and Science’, *Tidsskrift for kulturforskning*. Volume 7, nr. 3 (2008). 8.

discovered by interrogating peasants.¹⁸ His anatomical observation led him to describe insects to their fullest, and therefore created a multitude of hypotypes: any reader of his books can picture the insects he describes. However, according to Ogilvie, “for Aldrovandi, description was only part of the naturalist’s work; the history of insects embraced their meaning, not simply their objective nature.”¹⁹ Aldrovandi shared the principles of the emblematic world view: insects are more than what they look like, they have multiple meanings and it is the entomologist’s duty to capture this full understanding of what insects signify.

In *The Order of Things*, Michel Foucault explains and justifies the system of thought that Aldrovandi and his contemporaries used. According to him, “Aldrovandi n’était ni meilleur ni pire que Buffon ; ni moins attaché à la fidélité du regard ou à la rationalité des choses. Simplement son regard n’était pas lié aux choses par le même système.”²⁰ Both naturalists used different systems, that is, they both had different understandings on how to observe the natural world, an understandable disconnect that one could expect from naturalists from different centuries. This way of seeing the world took into consideration “synonymes et étymologies, différences, forme et description, anatomie, nature et mœurs, tempérament, coït et génération, voix, mouvements, lieux, nourriture, physionomie [etc.].”²¹ The emblematic worldview (according to Foucault) was predominant until the mid-seventeenth century; and anything linked to the comprehension of the natural world that preceded the seventeenth century was not part of his definition of natural history for the Early Modern period. In *The Order of Things*, Foucault differentiated history from stories, the latter being defined as any fable, tale, fiction, or work

¹⁸ Ibid., 7.

¹⁹ Ibid.

²⁰ Michel Foucault, *The Order of Things: an Archaeology of Human Sciences* (Vintage Books, 1973), 55. [Aldrovandi was neither better nor worse than Buffon, nor was he less attached to the fidelity of looks or to rationality of things. His look was just not linked to things by the same system].

²¹ Ibid., 54. [synonymies and etymologies, differences, form and description, anatomy, nature and customs, temperament, coitus and reproduction, voices, movement, places, food, physiognomy ...]

based on the supposed authority of the ancient world—all works lacking facts to prove their statements.²² In his essay, Foucault states that for natural history to appear, history had to become natural: the difference between *stories* about nature, and natural *history*, is that the latter is based on known facts, whereas the former is based on fiction.²³ However, I will argue that even though natural history is fundamentally scientific, fiction is an important tool that has to be used to understand the natural world. Fiction was – and still is – critical to our understanding of a complex world.

3) Naturalists and the pursuit of truth through the rise of new technologies

Beginning in the seventeenth century, the way in which naturalists and philosophers saw the world switched from the emblematic worldview to a paradigm where careful observation dominated. Foucault's definition of "natural history" does not lie in books and non-natural knowledge and facts; it urges naturalists to very carefully and very closely observe the surrounding natural world.²⁴ When naturalists started writing natural history rather than 'stories' of nature, they began sorting out truth from fiction.²⁵ Even though I do not believe that both forms of *histoire* are antithetical, but rather work in symbiosis, Foucault's understanding of the

²² Ibid., 141. "Jusqu'à Aldrovandi, l'Histoire, c'était le tissu inextricable, et parfaitement unitaire, de ce qu'on voit des choses et de tous les signes (...) : faire l'histoire d'une plante ou d'un animal, c'était tout autant dire quelles sont ses éléments ou ses organes (...) les légendes et les histoires auxquelles il a été mêlé, les blasons où il figure ..." [Up until Aldrovandi, History was the inextricable and joint fabric of what we see of things, and of their signs (...) to do the history of a plant or an animal, it is to say everything about their organs and their parts (...) the legends, stories, and coats of arm of which they are part ...].

²³ Ibid.

²⁴ Knowledge and fact are two words that work together quite well, but are not similar in meaning. In my thesis, I will consider fact as something that cannot be disputed, something that can be verified through experience. Knowledge can be based on facts, but it can also be based on beliefs. Therefore, both can work together, but this relationship is not intrinsic.

²⁵ Ashworth, "Natural History," 151.

natural world works on an invariable dichotomy.²⁶ Unlike Foucault, I believe that fiction is an important tool to use when deciphering the natural world, and that it is important to remember, particularly during the turn to the ‘age of reason’ of the 17th and 18th centuries. The idea of truthfulness brought up by Foucault indeed shifted throughout the seventeenth century, as Ashworth stated, using the example of Thomas Browne’s 1646 *Pseudoxia*: “The *Pseudoxia* is a concerted attempt to purge natural history of commonly, but erroneously, perceived truth.”²⁷ The *Pseudoxia* sought to verify every piece of information provided by previous natural history encyclopedias in order to sort false and fictional statements from true ones. Ashworth uses Browne as an example since he “clearly has a different view on nature from Aldrovandi,”²⁸ as, unlike the latter, Browne believed that observing is linked to experience rather than reading books. This shift in ways of seeing – and understanding – the natural world was then linked to experience and observation, both of which were themselves related to the creation and rise of new technologies.

Telescopes and microscopes were both invented in the early seventeenth century, and they both allowed groundbreaking discoveries. Thanks to these new technologies and observational tools, naturalists were able to verify what was previously written about insects, and uncover knowledge that had been outside the scope of their questions. Clearly, new technologies had an immense impact on the development of the field of the study of insects. Even though the word entomology only appeared in the eighteenth century after Swammerdam’s death, he came to be considered by later historians such as Jules Michelet (1798-1874) as “l’inaugurateur de

²⁶ The English words “history” and “story” are both translated into “histoire” in French, making it easier to misunderstand them and play with the polysemy of the word.

²⁷ Ibid., p.150.

²⁸ Ibid.

cette science.”²⁹ Born in 1637 in the Netherlands, he had always been close to the natural world and the curiosities it had to offer.³⁰ His research through the microscope lens helped broaden the understanding of insects: it enhanced his senses and allowed him to claim that knowledge from the previous century was only partly true or incomplete, since naturalists did not have access to the same depth of observation. For instance, naturalists used to believe that insects were born from dead bodies. Thanks to the microscope, Swammerdam found out that this misunderstanding was only a tale and discovered the truth about their procreation,³¹ proving that the microscope did help produce a better zoological and anatomical understanding of the insects’ world – or as Oglivie put it, “the newly invented microscope offered enhanced possibilities of observation, and insects could cast new light on problems in anatomy and generation.”³² Alongside Browne’s *Pseudoxia*, Swammerdam observed the natural world in order to verify or falsify past natural beliefs.

During his lifetime, the study of insects thrived among scientists, but also became part of the popular culture as men, women, and children around Europe entertained entomology as a hobby: there was no clear distinction between professional entomologist and bugs-amateurs.³³ As French historian of science Jacques Roger stated in *Les sciences de la vie dans la pensée française du XVIII^e siècle*, this wave of enthusiasm in regard to insects “s’explique tout

²⁹ Michelet, *L’insecte*, 69. [He is the one who inaugurated this form of science].

³⁰ See the first chapter of Paula Findlen, *Possessing Nature: Museums, Collecting, and Scientific Culture in Early Modern Italy*. (University of California Press, 1994). She talks about a curiosity of nature (Aldrovandi’s serpent with a bird’s feet), also referred to as a “monster”, a “monstrous dragon” (20 and 23) with an “unusual anatomy” (21), it is a “wonder of nature” (21). The word wonder will be used later in this chapter, while monster will be used in the next one. Those words and the ideas they convey are all intertwined.

³¹ Ibid., 142. Michelet writes: “il [Swammerdam] découvrit la maternité de l’insecte et prouva que ce ne sont pas des monarchies mais des républiques maternelles.” [He found out the insects’ way of procreation and proved that social insects].

³² Oglivie, ‘Nature’s Bible’, 6.

³³ Ian Hacking, *Representing and Intervening: Introductory Topics in the Philosophy of Natural Science*. (Cambridge University Press, 2010), 192. “the microscope became a toy for English ladies and gentlemen”.

naturellement pas *les découvertes inattendues et merveilleuses* que permit tout à coup un nouvel instrument d'observation, le microscope.”³⁴ Seeing minutely and understanding better seemed to be a way to think of the world in a more rational – at least a less fictional – way, but this rationality was also frightening as it opened new and seemingly endless curiosities. The microscope created a new relationship between sight and the natural world, one that would be more astute, more minute, and more accurate. However, this new relationship was also startling, for naturalists were frightened by the grandeur of the task to be accomplished.

Ian Hacking, in *Representing and Intervening*, argues that one does not really see through a microscope.³⁵ Looking through a microscope is a skill that naturalists needed to master in order to understand what they saw, or rather, believe what they saw.³⁶ According to Hacking, looking through the lens of a microscope creates more knowledge – and also more words – based on theories of perception. Looking through a microscope is not a passive task; it is an active task in which the subject is engaged in thinking about the act of seeing the object. The questions Hacking asks are similar to the ones that Réaumur asked when he considered the sixteenth-century emblematic world view: what information is to be trusted? How does the way one thinks about the nature of things change how one speaks of them and represents them? Can one trust a machine that is praised for revealing nature's true self? Even more, can one trust a machine that exemplifies human senses that are, for some naturalists, not to be trusted?

Indeed, when dealing with the world of insects, size becomes an issue. In his *Memoires*, Réaumur states: “Ajoutez que sa [l'insecte] petitesse ajoute au malentendu (...) nos très faibles

³⁴ Jacques Roger, *Les Sciences De La Vie Dans La Pensée Française Du XVIIIe Siècle: La Génération Des Animaux De Descartes à L'Encyclopédie* (Paris: Armand Colin, 1971), 182. [It explains itself through *the unexpected and marvelous discoveries* that a new observation tool allowed, the microscope]. My emphasis.

³⁵ Hacking, *Representing*, 189.

³⁶ *Ibid.*, 189.

yeux le voient trop confusément pour s'en expliquer la structure et l'utilité."³⁷ This quote indicates the difficulty of observing such animals because of their size and the weakness and inadequacy of human senses. Therefore, with Hacking's ideas in mind, it is natural to ask: Was the microscope a wonderful tool or an amplification of our poor human senses? Also, the definition of 'observing' has largely changed over time. Réaumur wrote in his *Mémoires*: "je ne suis pas assez persuadé si je soupçonne qu'on ne me parle que sur un oui dire: je ne le serai pas même assez, si on se contente d'avancer qu'on l'a observe."³⁸ He went on to give the methodology used in his own research: "j'ai détaillé avec soin les différentes manières dont je m'y suis pris dans ces sortes de recherches; on en sera plus en état de vérifier les faits que j'ai rapportés."³⁹ In the eighteenth century, naturalists and philosophers needed to be convinced by their own experiences rather than by taking for absolute truth what books claimed. However, the difference between believing and seeing remained since seeing had to be methodically followed and logged, so that others could independently verify facts. Moreover, since the act of seeing requires a human sense that could be deceitful, knowledge that relies on this sense becomes suspicious; hence Réaumur's description of his method in order to create a truth that is more factual and can be repeated if necessary.

Over the course of the seventeenth century, many thinkers contributed to the enrichment of knowledge in the field of entomology, and yet, an acute and well defined understanding of insects was still out of reach. For instance, even in the nineteenth century Michelet anthropomorphized his microscope, calling it a "muet homme de cuivre"⁴⁰ whose arms and eyes

³⁷ Réaumur, *Mémoires*, 12. [Add to that that their size does not help (...) our very weak eyes see them in such a confused way that they cannot figure out their structure and their purpose].

³⁸ Ibid., 26.

³⁹ Ibid., 44.

⁴⁰ Michelet, *L'insecte*, 140. [mute copper man].

acts like an assistant, another “organe de vérité,”⁴¹ the human “sixième sens”⁴². Through Michelet’s essay, the machine becomes human; perhaps a better version of mankind, with a more powerful sense of sight. However, since these machines amplify our senses that, in the first place, should not be trusted, would that mean that microscopes are even less trustworthy? Would they not be less truthful instruments? In this regard, should they be trusted more than our already fallible own human senses? If so, what tools should be used to get around this problem?

4) Insects, or the product of marvel, fiction and imagination

Fiction and imagination were some of the tools that naturalists used to read the natural world. As previously mentioned, Roger stated that the microscope facilitated some “découvertes inattendues et merveilleuses.”⁴³ The idea of wonder played a leading part throughout the seventeenth and eighteenth centuries, as Roger talked about “le gout du merveilleux”⁴⁴ of the time. Réaumur stated “Le goût du merveilleux est un goût general.”⁴⁵ Our modern French dictionaries define the “merveilleux” as “Ce qui s’éloigne du cours ordinaire des choses ; ce qui est miraculeux, surnaturel.”⁴⁶ It is something that is contrary to nature, that goes against it; it is something that cannot be explained by the laws of nature ; something singular that can only really be attributed to an act of God. The marvelous is that which cannot be produced by

⁴¹ Ibid., 158. [organ of truth].

⁴² Ibid., 111. [sixth sense].

⁴³ Roger, *Les Sciences*, 182. [unexpected and marvelous discoveries].

⁴⁴ Ibid. p. 183. [The taste for the marvelous].

⁴⁵ Réaumur, *Memoires*, 10. [The taste for the marvelous is a general taste].

⁴⁶ Larousse, Éditions. *Définitions : Merveilleux - Dictionnaire De Français*. N.p., n.d. Web. 05 June 2017. <<http://www.larousse.fr/dictionnaires/francais/merveilleux/50675>>. [Something that drifts away from the ordinary course of things, something that is miraculous, supernatural].

humankind and by their knowledge, and therefore is not natural. However, the definition given by Diderot and d'Alembert's *Encyclopédie* is much more detailed:

Les **fictions** & les allégories, qui sont les parties du système **merveilleux**, ne sauroient plaire à des lecteurs éclairés, qu'autant qu'elles sont prises dans la **nature**, soutenues avec **vraisemblance** & justesse, enfin conformes aux idées reçues; car si, selon M. Despréaux, **il est des occasions où le vrai peut quelquefois n'être pas vraisemblable**, à combien plus forte raison, une fiction pourra-t-elle ne l'être pas, à moins qu'elle ne soit imaginée & conduite avec tant d'art, que le lecteur sans se défier de **l'illusion** qu'on lui fait, s'y livre au contraire avec plaisir & facilite l'impression qu'il en reçoit?⁴⁷

Fiction, marvel and reality are all interwoven in this definition. In order for fiction and marvel to be plausible, they have to find inspiration in nature and be portrayed in a truthful and credible manner. This definition of *merveilleux* therefore contradicts our modern understanding of the word. The illusion has to be so good that the reader will not second guess the content of the book as a lie. What is more, the author also stipulates that what is true can sometimes not look the part, whereas a fiction inspired by nature and depicted in a credible way can seem more real than reality itself. This has multiple implications; the most important being that it confuses the idea of truth. Does the definition of truth remains the same when observing the natural world and when reading fiction? Since fiction and reality can sometimes be confused, can fictional writing about the natural world be considered truth? Does it have any authority whatsoever among naturalists?

The frontier between what is real and what is not becomes blurry. As Réaumur wrote in his *Mémoire*: “Il ne se trouve nulle part autant de merveilleux, et de merveilleux vrai que dans

⁴⁷ *Encyclopédie, ou dictionnaire raisonné des sciences, des arts et des métiers*, Eds. Denis Diderot and Jean le Rond d'Alembert, ARTFL *Encyclopédie Project*, Ed. Robert Morrissey (Chicago: University of Chicago, n.d.) <http://encyclopedia.uchicago.edu/>, V. 10: 393. Definition of “merveilleux”. [Fictions and allegories, which are the parts of the marvelous system, cannot please enlightened readers unless they are taken in nature, sustained with truth and accuracy, and in conformity with accepted ideas; for if, according to M. Despréaux, there are occasions when truth can sometimes be unreliable, for how much more so, a fiction can - unless it is not imagined and conducted with so much art, that the reader, without distrusting the illusion which is made of him, delivers himself on the contrary with pleasure, and facilitates the impression which he receives from it]. My emphasis.

l'histoire des insectes.”⁴⁸ The oxymoron “merveilleux vrai,” also called “merveilleux réel,”⁴⁹ summarizes this doubt by juxtaposing two contradictory words that work in tandem. What is implied in the words of Réaumur is that when naturalists started to observe the natural world in its materiality rather than reading about it as naturalists from the sixteenth century did, they realized how incredible the natural world can be, and how many discoveries there are yet to be made. Though they differed in methodology, Réaumur and sixteenth-century naturalists agreed that nature was so marvelous, such indeed that it could sometimes seem fictional to the naked eye, that a suitable language needed to be used, i.e. a fictional language, that is, a prose or discourse that will help philosophers understand the world without being rooted in reality. Fiction became a necessary component to showing truth. *Les mots* (signifiers,) and *les choses* (or signified,) were separated by an invisible wall that these naturalists had to break through with the use of a fictional language. However, another implication of this definition of *merveilleux* is that the natural world, through this language, can at times be too spectacular, too fantastical, and therefore entirely non-plausible. Considering this, fictional language was then the only way for naturalists to describe the wonders they were observing. Fiction was the only tool they could use to put their discoveries into words, and therefore was an important way of making sense of the natural world.

The study of insects in the seventeenth and eighteenth centuries was fairly new; indeed, what became entomology really started to take shape in these two centuries. Therefore, naturalists must have felt like explorers in a new world, discovering more and more about the ‘culture’ and way of life of these newly discovered (yet wholly ancient since they were on Earth before mankind) inhabitants of the planet. Indeed, “everyone expected to find worlds within

⁴⁸ Réaumur, *Memoires*, 10. [One cannot find any more marvelous, and true marvelous, than in the history of the insects]. As Werber also said: “The more it is true, the more it is magical.”

⁴⁹ *Ibid.*, 351.

worlds here on earth,”⁵⁰ but in order to do so, not only did they have to cautiously observe insects, they also had to use their imagination to garner a full understanding of the world around them. In fact, Roger stated that “L’imagination du chercheur va d’ailleurs au delà de ce qu’il voit (...) car nous sommes incapables de concevoir l’extrême petitesse des parties dont ces animaux sont composés.”⁵¹ Even if the microscope enhanced naturalists’ sight and allowed them to grasp a better understanding of insects’ anatomy, they still had to fill in the knowledge gaps by using their imagination.

Interestingly, Voltaire defined *imagination* in the *Encyclopédie* as “le pouvoir que chaque être sensible éprouve en soi de se représenter dans son esprit les choses sensibles,”⁵² based on previous knowledge perceived through the senses. This definition poses some issues: imagination is the result of a process based on human senses and is therefore based on preconceived ideas and encounters from one’s previous life. Once again, senses, as ways to perceive the world, are controversial tools, and by using their imagination, naturalists imposed previous experiences and memories on unknown insects. These had nothing to do with insects, since naturalists were making discoveries based on observation alone, rather than something encountered in the past. Insects became a collage of different representations based on the knowledge that naturalists garnered about other living beings. Insects became a space in which naturalists imposed reminiscences that had nothing to do with them, logical fallacies, memories, ideas, and known perceptions of the world that would not have been attributed to insects before.

⁵⁰ Hacking, *Representing*, 187.

⁵¹ Roger, *Les Sciences*, 183. [The searcher’s imagination goes beyond what he can see (...) because we are unable to conceive].

⁵² *Encyclopédie, ou dictionnaire raisonné des sciences, des arts et des métiers, etc.*, eds. Denis Diderot and Jean le Rond d’Alembert. University of Chicago: ARTFL Encyclopédie Project (Spring 2016 Edition), Robert Morrissey and Glenn Roe (eds), <http://encyclopedia.uchicago.edu/>. V. 8: 560. Definition of “imagination”.

Knowledge about insects was as much a product of observation as it was a product of imagination: these two perceptions shared a space in the representation of truth of insects.

Yet, it appears that naturalists were in fact aware of their limited abilities, as Réaumur states “mais combien de merveilles nous sont cachées, et le sont pour toujours ! (...) les merveilles prodiguées dans la construction intérieure des insectes nous échappent,”⁵³ and those ungraspable facts are not restricted to the modern period, as even in the nineteenth century, naturalists seemed to face the same difficulties.⁵⁴ Indeed, even a century after Réaumur, Michelet lacked tools to help the study of insects as he wrote that “Nos doigts énormes ne prennent plus; ils font ombre, ils font obstacles. Nos instruments sont grossiers pour opérer sur ces atomes.”⁵⁵ Whether it be the sense of touch or sight, senses have always been obstacles for naturalists. They were not powerful enough and too disproportionate to work on such small creatures. However, even though there is a disconnect between our senses and how we relate to the world of insects, this disconnection creates a space that allows naturalists to give a unique insight into the insect world. Knowledge is therefore the product of a space created between the senses and the beings on which they are applied, it is the product of the absence of sufficient tools to understand such tiny creatures; indeed, the product of observation and imagination and – ultimately – its goal is to find nature’s true self. Yet, if truth was the ultimate goal of precise and patient observation linked to imagination, something was still missing since, as Michelet states in his introduction, “Trouvé, pris, ouvert, disséqué, vu au microscope et de part en part, il nous reste encore une énigme. Une énigme peu rassurante, dont l’étrangeté est près de nous scandaliser, tant elle

⁵³ Réaumur, *Memoires*, 14. [How many marvelous things are hidden and will remain hidden forever (...) the marvels dispensed by the internal construction of insects escapes us].

⁵⁴ Michelet, *L’insecte*, 293. “A cette vive gesticulation, elles joignent beaucoup d’autres mouvements peu explicables”. [To this quick gesticulation, they combine many other movements barely explainable].

⁵⁵ Michelet, *L’insecte*, 141. [Our humongous fingers hinder the study of insects. Our tools are too inaccurate to operate on those atoms].

confond nos idées.”⁵⁶ Indeed, the microscope revealed to naturalists how little they knew about insects and helped them improve their knowledge. It could not answer all the questions naturalists and philosophers had about the observations they made. Imagination had to come to the aid of naturalists in order to try to make sense out of the new vision they had of the world.

5) The power of hypotheses, or how to reconcile two worlds

Naturalists needed to roam within the world of insects in order to gather as much information as possible through attentive observation, and subsequently used their imagination to organize their knowledge such that it would make sense. Indeed, the term *merveille* was closely linked to theology and to the idea of something that cannot be explained, but that had been brought down to earth by God to test human faith.⁵⁷ Knowing this, it is no wonder that naturalists had to use words and expressions that would not be considered as being suited for science – in a modern sense – in order to talk about insects. For instance, the lexical field of a fantastic and marvelous worlds are recurrent in Michelet’s *L’insecte* as he compares nature to a fairy multiple times: “La vraie fée, c’est la nature”, “ce lieu fée”, “la fée d’ici a je ne sais combien de visages” or “la fée fantasque.”⁵⁸ However, he also states in his introduction that the word fairy is too mobile to really express “ce mystère du profond bassin caché,”⁵⁹ a metaphor he uses to describe

⁵⁶ Ibid., VI. [Found, taken, opened, dissected, seen through a microscope from one end to the other, an enigma remains. An enigma that is not reassuring, whose strangeness is about to scandalize us since it conflates our ideas].

⁵⁷ Lorraine Daston, and Katharine Park, *Wonders and the Order of Nature: 1150-1750* (Zone Books, 2001). 39. “The authors of encyclopedias, bestiaries, and similar collections emphasized the symbolic uses of wonders as keys to scripture, repositories of moral lessons, and testimonies to the benevolence and omnipotence of the Christian God.”

⁵⁸ Ibid., 31, 32, 33 and 34. [Nature is the real fairy]. [This enchanting place]. [The fairy that lives here has countless faces]. [The whimsical fairy].

⁵⁹ Ibid., XXXI. [this mystery of the deep hidden pond].

the forest in Fontainebleau where he studied insects in their natural habitat. This forest appeared to be a completely different world, as if one had to leave Earth – and its laws and rules – in order to understand the world of “le grand peuple des ténèbres.”⁶⁰ The metaphors he used show that the insect world is hard to define, and as such has to be metaphorically compared through the use of terms to which people can relate. The fact that he has to resort to figurative language to speak of the natural world – which is supposed to be observable and explainable through the senses – says something about the world of insects. By trying to bring his reader closer to the insects he loved so much through his use of language, Michelet moved them away from what really is, and indeed separated them from their object of study. The two worlds – the human and the insect – are separated, and by consequence naturalists are alienated from the natural world, with only the power to formulate hypotheses to make sense of the world of insects.

Nonetheless, it should be acknowledged that having the power to formulate a hypothesis should not be underestimated. The word hypothesis is defined today as a “proposition visant à fournir une explication vraisemblable d'un ensemble de faits, et qui **doit** être soumise au contrôle de l'expérience.”⁶¹ Hypothesis and experience are linked, the latter serving as a verification for the former. However, in the eighteenth century, the *Encyclopédie* defined the term as:

la supposition que l'on fait de certaines choses pour rendre raison de ce que l'on observe, quoique l'on ne soit pas en état de démontrer la vérité de ces suppositions. Lorsque la cause de certains phénomènes n'est accessible ni à l'expérience, ni à la démonstration, les Philosophes ont recours aux *hypotheses*⁶²

He also writes “Monde de mystères et de ténèbres” p.44. [World of mystery and darkness].

⁶⁰ Ibid., XVII. [The great people of darkness].

⁶¹ Larousse, Éditions. *Définitions : Hypothèse - Dictionnaire De Français*. N.p., n.d. Web. 05 June 2017. < www.larousse.fr/dictionnaires/francais/hypothèse/41267?q=hypothèse#41163 >. [proposition that aims to give a rational explanation for a group of facts and that must be verified through experiences]. My emphasis.

⁶² *Encyclopédie, ou dictionnaire raisonné des sciences, des arts et des métiers, etc.*, eds. Denis Diderot and Jean le Rond d'Alembert. University of Chicago: ARTFL Encyclopédie Project (Spring 2016 Edition), Robert Morrissey and Glenn Roe (eds), <http://encyclopedia.uchicago.edu/>. Article “hypothèse”.

Here, a hypothesis is a statement one makes after observing the natural world when the causes of phenomenon cannot be verified *a posteriori* and cannot be verified *a priori*. Hypotheses did not have to be proof tested by experience – indeed quite the opposite. When the natural world could not be explained, naturalists would resort to using hypotheses: explanations that cannot be proven, and this goes back to the idea of using imagination to explain the natural world.

Hypothesis, just like imagination, can provide structuring principles that evade the question of proof: naturalists give, through their writing, ideas to other people who might have contradictory arguments; imagination and hypothesis become stylistic tools to write about the natural world and try to find nature's hidden true self and read between the lines of nature. Imagination and hypotheses – far from being hindrances to knowledge-making – become literary tools to understand the natural world.

Hypotheses are as much a part of literature as of science. Emile Zola explained in his *Roman Expérimental* (1880) that artists, especially authors, are ahead of science because they create hypotheses in their writing, and that those hypotheses have to be verified by science in order to be approved or rejected.⁶³ That statement could explain why Réaumur and Michelet had to articulate through suggestions the reasons why insects behave in particular ways: they relied on a literary-scientific tool because purely scientific tools that they had at that time were not sufficient. For instance, Réaumur writes: “Peut-être que quand ces chenilles font entrer les picquants des orties dans leur bouche, elles les y font toujours entrer dans un sens où ils ne sauraient les piquer, qu'elles les font entrer par leurs bases”⁶⁴ while Michelet, one century later, wrote “On a appelé cela des jeux ; mais je ne savais pas qu'en croire. ... cette gymnastique a

⁶³ Emile Zola, *Le Roman Expérimental* (Paris: Garnier-Flammarion, 1971).

⁶⁴ Réaumur, *Memoires*, 97. [Perhaps those caterpillars always eat those nettle by always putting them in their mouth in the same direction so that they would not get stung by their needles].

peut-être un but hygiénique que nous ne savons pas.”⁶⁵ By suggesting answers through words such as ‘maybe’ or ‘perhaps,’ Réaumur and Michelet both make it clear that they do not have all the answers on the study of insects. By using these terms, both naturalists are trying to make sense of the world, they are trying to find the principles that would fit what they observed and what they believed about insects. By using these words, they also opened up discussions among naturalists by formulating hypotheses, because indeed, why not?⁶⁶ All things considered, hypothesis – just like imagination – was used as a literary tool to write about the unknown parts of the natural world. By using them, naturalists essentially wrote fiction based on their observation about the natural world, as their statements cannot be proved and, therefore, cannot be approved or refuted by natural facts.

It cannot be refuted that naturalists – over centuries – have helped shaped the definition and understanding of insects commonly shared today. Through observations, essays, hypotheses, imagination and experiences, many naturalists have participated in the building of mutual knowledge regarding insects and entomology. They “demystified the rainbow” of insects by giving scientific laws and rules, yet, the question remains: how should one consider past naturalists’ works? Did they give natural explanations about why the natural world is the way it is, or did they have to use hypotheses and their imagination as tools to do so? If they used both concurrently, how to differentiate one from the other? Shortly stated: is it natural knowledge or

⁶⁵ Michelet, *L’insecte*, 294. [Some called that games, but I did not know what to think about it ... maybe this gymnastic had a hygienic goal that we do not know about?].

⁶⁶ This idea of the *pourquoi non* [why not] was raised by Bernard le Bouyer de Fontenelle (1657-1757) in his *Entretiens sur la pluralité des mondes* (1686). “This 'Why not?' has a power which allows it to populate everything.” (91) Fontenelle uses the idea that “there are as many species of invisible animals as visible” (92), that “a lot of bodies that look like solides are only amalgamations of these imperceptible animals” (94), and that a mite is itself an elephant to other tinier species. These ideas of relativity and perspective will be more developed on chapter 3.

fictional knowledge and how can we make the distinction between the two? Did this relationship last until today or has it changed over time?

6) What about the twenty-first century?

To attempt to answer these questions, let us consider the definition of fiction given in the *Encyclopédie*. According to Marmontel, fiction is a “production des Arts qui n'a point de modele complet dans la *nature*. (...) L'imagination compose & ne crée point (...) La *fiction* doit donc être la peinture de la vérité, mais de la vérité embellie.”⁶⁷ In other words, fiction is an embellished version of reality composed by one’s imagination, since imagination can only compose with what it has already in store. Though it is a reflection of reality, fiction is a composition: by taking the ingredients of reality and by recombining them, imagination makes an embellished version of truth. Fiction is a non-real product which serves to depict reality by being based on real components. From this point of view, naturalists’ works *are* fictional because of the use of hypotheses and the use of the imagination: both literary tools are based on real elements, but they are organized in a way that pushes knowledge in the unknown. Naturalists told stories about nature; stories that may or may not be true, but were convincing about their truthfulness.⁶⁸ It is only through personal experience that one can make up his or her mind about apparent fictions. Because naturalists were talking about the natural world in a fictional way, they *should* be regarded as early science fiction writers.

⁶⁷ *Encyclopédie, ou dictionnaire raisonné des sciences, des arts et des métiers, etc.*, eds. Denis Diderot and Jean le Rond d'Alembert. University of Chicago: ARTFL Encyclopédie Project (Spring 2016 Edition), Robert Morrissey and Glenn Roe (eds), <http://encyclopedia.uchicago.edu/>. Article “fiction”. Vol. 6:680.

⁶⁸ See note 46. In the definition of merveilleux of the *Encyclopédie*, fictions are part of the marvelous and, when written subtly, can pass for reality.

Indeed, even though the word ‘science fiction’ appeared decades later, the idea of science existed before the word was invented. Moreover, even though the definition of fiction had been written in the eighteenth century, it is still relevant in modern writings, for the idea of hypotheses and imagination are still used as the joint between the natural world and literature, particularly in contemporary science fiction. As an example, contemporary science fiction author Bernard Werber said in an interview to promote *Troisième Humanité*, his latest novel at the time, that he was writing “une hypothèse, une potentialité.”⁶⁹ He used this process in most of his novels: in *L’Empire des Anges*, published in 2000, he expressed a hypothesis of what comes after death (a theme that will also be at the center of his latest novel *Depuis l’au-delà* published in 2017.) In *Le père de nos pères*, published in 1998, Werber imagines what the origin of humankind is. Insects were the first topic he ever pondered, in his novel *Les Fourmis* published, in 1991.

Interestingly, in this work, he does not only call them insects: “avant de chercher des extraterrestres aux confins de l’espace, il convenait d’abord de faire la jonction avec les... intraterrestres.”⁷⁰ The word ‘intraterrestre’ is a neologism, it is an unknown lexicon to talk about something as common as insects. And yet, this word, even though it is absent from any French dictionary, makes sense to the reader: from the idea of extraterrestrial, one reflects upon an alien form of life that lives on Earth, which humans have not sufficiently questioned and that their senses cannot fully grasp. Werber is opening his readers’ minds so that they can imagine the insects’ world. Under his pen, insects are *re*-discovered, implying that our current knowledge about them might not be sufficient. By using metaphorical language, Werber puts the insect into

⁶⁹ Hélène Pau, "Bernard Werber: "La Science-fiction Me Permet De Partager Mes Intuitions Du Futur"." *IRIS, école De L'intuition*. N.p., 21 Oct. 2013. Web. 05 June 2017. <<http://www.iris-ic.com/bernard-werber-science-fiction-permet-partager-mes-intuitions-du-futur/>>. [I submit an hypothesis to my readers, a potentiality].

⁷⁰ Bernard Werber, *Les Fourmis* (Paris: Albin Michel, 2010), 281-282. [Before looking for extraterrestrial forms of life on the edges of space, it seemed at first necessary to make the junction with the ... intraterrestrial forms of life].

perspective: no matter how advanced the field of entomology and how powerful our microscopes are, insects still remain largely unknown and mysterious. Swammerdam, Réaumur, Malphigi, Fabre, Michelet, all helped demystify insects, and yet, insects remain a seemingly intraterrestrial form of life mostly unknown to mankind.

As a matter of fact, people's ideas about insects are what pushed Werber to write about them in the first place: he wrote his book after years of observations and research, demonstrating that insects have always been underestimated because of their size.⁷¹ Werber insinuates that the fear of the unknown remained throughout the centuries, even though scientists are now able to see far beyond what was visible three hundred years ago. For centuries, naturalists have been trying to understand the worlds of insects, and yet, it seems that insects are still surrounded by an impenetrable mystery. Even further, "L'insecte dérouté, il est plus petit et plus fragile que nous, et pourtant il nous nargue et même nous menace."⁷² Here, the author frames insects as purveyors of fear, and yet, when one takes the time to observe them, a whole new world opens up, displaying a different, novel perspective on life. Werber has always been fascinated by ants "parce qu'on peut les approcher sans qu'elles soient gênées. C'est en les observant que j'ai eu l'idée d'envisager autrement la cité humaine."⁷³ Werber owned an anthill, which helped him to observe them. Insects such as bees, termites, and ants, are social insects: by looking at them, the observer has the unique feeling of viewing a society of thousands of individuals from a nearly omniscient and omnipotent point of view.

⁷¹ Bernard Werber - *Interview Dans La Presse*. N.p., n.d. Web. 08 June 2017.
<<http://www.bernardwerber.com/interviews/Magnard.html>>.

⁷² Bernard Werber, *Les Fourmis*, 74. [The insect throws us, it is smaller and more fragile than us, and yet, it taunts us, it even threatens us].

⁷³ *PressReader.com - Connecting People Through News*. N.p., n.d. Web. 08 June 2017.
<<http://www.pressreader.com/france/aujourd'hui-en-france/20121004/282248072781231>>. [Because they can be approached without being hindered. It was by observing them that I had the idea of considering otherwise the human city].

Indeed, the study of social insects has a characteristic that the study of larger animals does not have. We may be able to observe herds or families of larger animals living together, but observing social insects is akin to encompassing an entire city of animals. From the observer's point of view, being able to watch an entire city of social insects, rather than a few larger animals living in herds, is fascinating as insects reveal the laws of their 'society.' For Werber, it was more than that:

Dans ce livre, (...) je ne parlais pas des fourmis mais bien des humains, explique-t-il. Or les journalistes n'ont rien compris. Ils n'ont voulu voir que l'obsession d'un chroniqueur scientifique alors que j'avais entrepris de faire de la science-fiction en n'usant que de la réalité⁷⁴

Werber used insects in a scientific way to talk about humankind in a literary manner. This novel is an example of how science and literature work in symbiosis. However, science and literature have not always worked so well together: C.P. Snow stated in his book in *The Two Culture and the Scientific Revolution*,⁷⁵ "the two cultures" have been separated by society in what seem to be an irreversible way. Werber makes these two cultures work in tandem rather than impeding one another. Indeed, more than simply trying to get these ideas to work together, Werber, in his writing, goes back to an old literary tradition that linked the natural world with all manners of things. Werber, in his own way, is a contemporary writer seeing the world through an emblematic world view. He writes:

L'insecte a longtemps été considéré comme l'incarnation du mal. Belzebuth, l'un des suppôts de Satan est par exemple représenté avec une tête de mouche (...)

⁷⁴ Jean-Yves Nau, "Bernard Werber, Le Neurone Pensant." *Le Monde.fr*. Le Monde, 25 Mar. 2002. Web. 08 June 2017. <http://www.lemonde.fr/archives/article/2002/03/25/bernard-werber-le-neurone-pensant_268118_1819218.html?xtmc=bernard_werber_le_neurone_pensant&xtcr=2>. [In this book that I started when I was 16 years and that has been refused for six years by forty publishers, twice by Albin Michel, I did not talk about ants but actually about humans, he explains. But journalists did not understand. They only wanted to see the obsession of a scientific columnist when I decided to do science fiction by using reality only].

⁷⁵ Charles Percy Snow, *The Two Culture and the Scientific Revolution*. (Cambridge University Press, 1959).

Toutes les cultures en [des fourmis] parlent différemment. Dans le Talmud, elles sont le symbole de l'honnêteté. Pour le bouddhisme tibétain, elles représentent le dérisoire de l'activité matérialiste. Pour les Baoulés de Côte-d'Ivoire, une femme enceinte mordue par une fourmi accouchera d'un enfant à tête de fourmi. Certains Polynésiens, en revanche, les tiennent pour de minuscule divinités⁷⁶

In order to fully understand what an ant is – and what an ant represents – it is necessary for Werber to demonstrate that the idea of an insect can take on a complete different meaning depending on the culture or region from which the reader is. By understanding and defining insects differently, through different lenses and different cultures, Werber offers his reader a more complete overview and understanding of insects rather than the commonly accepted definition in his own culture. Werber employs very specific and scientific terms in his work, particularly when talking about insects, and yet, similar to the naturalists from the sixteenth century, he includes the insects in a system of thought that includes anything related to insects.

Giving a simple definition of what an insect is can be a difficult – if not impossible task – since “il existe plusieurs manières de comprendre ces insectes.”⁷⁷ There are as many definitions of what insects are as there are potential ways of analyzing, studying and observing them. At one point in *Les Fourmis*, Werber compares two different schools of thought that have divergent opinions on insects. On the one hand, the ‘German school’ believes in a hierarchy among ants where some are better than others;⁷⁸ and on the other hand, the ‘Italian school’ believes that any

⁷⁶ Werber, *Les Fourmis*, 74. [The insect has long been considered as the incarnation of evil. Belzebuth, one of Satan's accomplice is depicted with a fly instead of the head (...). All cultures speak about ants differently. In the Talmud, they are the symbol of honesty. For Tibetan Buddhism, they represent the derisory of materialistic activity. For the Baoule of Côte d'Ivoire, a pregnant woman bitten by an ant will give birth to a child with an ant's head. Some Polynesians, on the other hand, believe they are tiny divinities].

⁷⁷ Ibid., 178. [There are multiple ways of understanding insects].

⁷⁸ “M. Burmeister met en tête de chacune de ses series les ordres les plus inférieurs sous le rapport de l'organisation; mais Lamarck, comme personne ne l'ignore, l'avait fait longtemps avant lui et même avant aucun auteur de l'école philosophique allemande”

(<https://books.google.com/books?id=0QgAAAAAQAAJ&pg=PA672&lpg=PA672&dq=ecole+allemande>)

ant can become a leader for a short amount of time as needed, but that they are all equal.⁷⁹

Professor Leduc, one of the characters, belongs to the ‘German school of thought’ “qui veut modifier l’humanité en copiant sous un certain angle les mœurs des animaux.”⁸⁰ In this novel,

ethology – the study of animal and human behavior – is pushed to the extreme. How is it possible in the first place to copy animals whose way of life scientists cannot understand?

Certainly, the overall understanding of what an insect is is clearer; but it is also debatable entomologically. Even though Aristotle, Swammerdam, Réaumur, Michelet or Werber all wrote about and observed the same object, they all treated insects in a different way, bringing their epistemological and contemporary paradigms to their studies. In a way, there are as many potential definitions as there are observers, all arguing that their hypotheses are more correct than others.

However, what Werber demonstrates via his novel is that giving a definition to insects is simply impossible, because “L’insecte, c’est une autre philosophie, un autre espace-temps, une autre dimension.”⁸¹ Some might think that ant societies are anarchist, others would say fascist, yet others would prefer royalist, but at the end of the day, naturalists are observing another species using human terms and concepts. Even though both species live in the same world, they do not share it.⁸² This debate also existed in the nineteenth century, when Michelet was conducting his research, and his reasoning and conclusion seem quite similar to Werber’s as he stated: “Est-ce à dire qu’il faille copier? Point du tout. (...) Il faut les aimer seulement, les

[+entomologie&source=bl&ots=27rN2mip4p&sig=6I0PEJpThjFbfbMRfxcpgU2EPg4&hl=fr&sa=X&ved=0ahUKEwiT7YLphZDZAhuic98KHeyACPgQ6AEINDAD#v=onepage&q=ecole%20allemande%20entomologie&f=false](#)) [Mr. Burmeister places at the front of each of his series the most inferior orders, but, as one knows, Lamarck was the first to do so, even before anyone from the German philosophy school of thought]. The idea of the organization of the natural world will be at the core of the second chapter.

⁷⁹ For more details, see *Ibid.*, 176-177.

⁸⁰ *Ibid.*, 287. [They want to modify humankind by copying certain aspects or insects’ way of life].

⁸¹ *Ibid.*, 75. [The insect belongs to another philosophie, another space-time, another dimension].

⁸² *Ibid.*, 294.

contempler, s'en inspirer, et en tirer des formes idéales.”⁸³ Michelet and Werber both believed that insects are worth studying and observing: Michelet for the marvel one can discover, and Werber, for how copying insects and describing their behavior in human language would be a fatal error for mankind. Insects cannot be understood from a human perspective, if from any perspective at all, as humans tend to reference their world from a singular – and selfish – perspective: “On peut décrire les insectes, on est contraint de les admirer, on ne peut pas les comprendre.”⁸⁴ The impossibility of understanding insects – of giving them a fixed definition – gives naturalists room for hypotheses and gives room to authors to write fiction that explores an object of study that is multifaceted. From here, new and different analyses, hypotheses, ideas, images, and can even lead to the use of a different language are conceived.

The definition of what an insect is has changed over time, as has the way naturalists were able to observe them. From an emblematic world view, the seventeenth century focused on ocular observation, namely through the microscope. In the eighteenth century with Réaumur (and the nineteenth century with Michelet) the understanding of insects' worlds led to a sense of marvel and fascination. Today, even though science and scientific tools are improving continuously, the understanding of what defines an insect is still not clear and fixed: science fiction gives us a potential explanation; or at least the tools we need to learn to speak a radically different language and to see new paradigms. Our understanding today includes fables, mythologies and other non-scientific media and genres, which bring us back to the emblematic world view from the sixteenth century. This chapter has focused only on the understanding of insects and the way they have been observed over time; it is now necessary to take a step back

⁸³ Michelet, *L'insecte*, 296. [Does that mean that we should copy them? Not at all. We should only love them, contemplate them, get inspired by them, and draw from them perfect forms]

⁸⁴ Roger, *Les Sciences*, 448. [We can describe the insects, but we can only admire them, we cannot understand them].

and look at ants on a larger scale. What is their relationship within the greater cosmos of living beings? What is their place in the world?

ZOOPHYTES, INSECTS, AND THE MATERIALIST CHALLENGE TO THE GREAT CHAIN OF BEING

1) Introduction

As I explained in the previous chapter, ways of understanding the world changed from century to century, and the tools naturalists had at their disposal to help them with this task changed over time as well. By understanding how naturalists observed and understood insects—and especially after examining how convoluted this understanding was – it is worth examining how this understanding of insects impacted taxonomical systems. In *Les Sciences de la vie dans la pensée française du XVIIIe siècle*, Roger indicates that the study of insects “rendait beaucoup plus improbable une vision unifiée et rationnelle de l’univers.” Since “les insectes déroutaient les savants, refusaient d’entrer dans les cadres traditionnels, ruinaient les analogies les plus solides et les lois les plus acceptées,”⁸⁵ it is clear that the study of insects had an impact on the understanding of the natural world. Because insects were difficult to observe, to understand, and to define, they interfered with preconceived and deeply rooted taxonomical issues. Because of these difficulties, did natural philosophers marginalize insects so that their taxonomical rules would make more sense? Did these newly (re)discovered insects change naturalists’ view on nature? Did they have to tweak laws of nature as they understood them so that insects would not shatter preconceived ideas about how the world was organized? Who first attempted to categorize insects within taxonomical system?

⁸⁵ Jacques Roger, *Les Sciences de la vie dans la pensée française du XVIIIe siècle: la génération des animaux de Descartes à l’Encyclopédie* (Paris: Armand Colin, 1971), 238. [made way less probable a unified and rational vision of the universe (...) insects threw off balance naturalists, they refused to fit in traditional frameworks, they ruined the most solid analogies and the most accepted laws]. Unless otherwise noted, all translations from the French are my own.

Discovering order in the world is one of philosophers and naturalists' main goals, as understanding the rules of the environment enables them to better situate themselves in the present, understand the past, and above all, to better define the future. Some even believe that when one understands the mechanisms of the world, one can reverse it and understand the past – or how they got to where they are in the present – and they can hypothesize logical futures based on its patterns. As philosophers and naturalists analyzed the natural world, they also attempted to understand its laws to find their place within it, and in doing so participated in the idea and tradition called the 'Great Chain of Being.' Coming from an ancient tradition first outlined by Aristotle, naturalists have since added their own thoughts and ideas, modifying ancient conceptions of the world to better define the new taxonomical rules of their time. Indeed, as ideas and observational tools and methods changed over time, so did the philosophers' understanding of the world and the rules for its order. With a better understanding of what was out of reach beforehand, whether because it was too far (telescopes) or too small (microscopes), naturalists' approach to the natural world was different, and their understanding shifted as observational tools became available. Different observations of the natural world – and I understand the term observation in its polysemy and with its many implications outlined in chapter one - have informed how naturalists saw how the world was organized.

2) Lovejoy's *The Great Chain of Being* put in perspective through Réaumur's thoughts

Arthur O. Lovejoy investigated the history of ideas about how naturalists ordered and understood life from Aristotle to nineteenth century biologists in his book *The Great Chain of Being* (1936). According to Lovejoy's understanding of Aristotle, three principles governed the natural world: plenitude, continuity, and gradation. These three principles were interdependent. Aristotle's principle of plenitude entailed "that the world is the better, the more things it contains."⁸⁶ Lovejoy also indicated that species are the creation of an "inexhaustible source," and that God is the creator of the natural world and organizer of the beings that populate it.⁸⁷ The second principle of continuity implied that the universe could only be complete if there were no gaps in creation. The third principle of gradation demanded that each being be situated at a fixed and invariable rank, above a being that is inferior to it, below a being superior to it. There has to be a continuity in the logic by which this ranking finds its order. God gives his creatures a certain degree of goodness – also referred to as a degree of perfection – that ranks them linearly in the Chain of Being. God is omnipresent and omnipotent as he rules over the Chain of Being. He decides the natural and moral order of the world.⁸⁸

According to Lovejoy, the eighteenth century is when formal taxonomical systems truly emerged, thereby creating various ways to interpret Aristotle's three principles and altering our understanding of the organization of the natural world. For instance, the God that Lovejoy writes about is an important factor in the way Réaumur organized his thoughts and how he understood the world. Indeed, Réaumur asked in his *Mémoire*: "Devons-nous rougir de mettre même au nombre de nos occupations, les observations et les recherches qui ont pour objet des ouvrages ou

⁸⁶ Arthur O. Lovejoy, *The Great Chain of Being; a Study of the History of an Idea* (Cambridge, MA: Harvard University Press, 1936), 52.

⁸⁷ Ibid., 52.

⁸⁸ Ibid., 58-59.

l'Être suprême semble s'être plu à renfermer tant de merveilles, et à les varier si fort ?”⁸⁹

Réaumur thus anchored his ideas in a theological paradigm. In the eighteenth century, some of his fellow naturalists considered the study of insects to be a mockery; insects, according to Roger, “était généralement dédaignés.”⁹⁰ Similarly, according to Réaumur’s contemporary and rival, Buffon, “Une mouche ne doit pas tenir dans la tête d’un Naturaliste plus de place qu’elle n’en tient dans la Nature.”⁹¹ However, according to Réaumur, the study of insects – far from being a mockery – was a way to witness the natural world’s perfection, as insects, in Réaumur’s thought, were its most fastidious beings. For him, observing insects was a way to prove the existence of a greater being from which everything emanates; it would prove the existence of an all-mighty God who has the power to create such tiny, yet perfect beings. Roger states that “Les monstres, comme les insectes, comme tout ce qui vit, portent la marque d’un Dieu rigoureusement inconnaissable, d’un Dieu étranger à l’homme.”⁹² The perfection of insects is the mark of a greater horologist, of a God who has the power to create such perfect living beings with such perfect mechanics. Their relevance in the natural world is thus praiseworthy: they have to be understood as a proof of the existence of God. Even if, according to Roger, insects made people fearful and scared that God was perhaps unknowable, it still implies that there *is* a God from which those insects originated.

Réaumur, through his *Mémoires*, allowed changes in the Chain of Being, as the perfection of insects’ mechanisms creates beings ‘superior’ to mankind in a physiological way. The

⁸⁹ Réaumur, *Mémoires*, 4. [Should we blush about the fact that we have among our occupations the research and study of beings in which the Supreme Being’s placed so much marvel and that he diversified this much?]

⁹⁰ Roger, *Les Sciences*, 234. [were generally looked down upon].

⁹¹ Georges Louis Leclerc de Buffon, *Histoire naturelle, générale et particulière, avec la description du Cabinet du Roy*, Vol. 4 (Paris: Imprimerie royale, 1749), 92. (Discours sur la Nature des Animaux) [A fly should not take as much space in a naturalist’s mind than the one it takes in nature].

⁹² Roger, *Les Sciences*, 448. [Monsters, just like insects, just like everything that is alive, they all carry the mark of a rigorously unknowable God, a God that is a stranger to mankind].

handicraft needed to create such tiny yet harmonious and functioning living beings could only be but a source of jealousy coming from mankind, as Roger summarized: “Et l’homme peut se demander qu’elle est sa place dans l’univers, en voyant que les créatures les plus humbles et les plus méprisées surpassent, par les prodiges de leur organisation et de leur instinct, la belle ordonnance si longtemps célébrée de l’anatomie humaine.”⁹³ Their perfection would therefore question or supersede the idea of the Great Chain of Being, or as Roger states, “L’ordre de la nature s’évanouit dans le mystère divin.”⁹⁴ The order of the natural world, and contemporary taxonomical ideas, were weakened – if not shattered – by the study of insects. The discovery of the perfection and intricacy of insects’ mechanisms and bodies, when compared to the rest of the natural world, led natural philosophers to rethink the human body and its place within a greater system, as they realized that God created insects with greater physiological mechanisms than their own bodies.

Yet, this *instinct* Roger implied when reflecting upon insects’ perfection could be understood in Réaumur’s language as *intelligence*. Indeed, Réaumur considered insects as being not only perfect, but pushed this perfection as far as allowing them to have received some intelligence by a greater force. He wrote:

Mais refuserons-nous toute intelligence aux insectes ; les réduirons nous au simple état de machine ? C’est là la grande question de l’âme des bêtes, agitée tant de fois depuis M. Descartes ... il est impossible de démontrer lequel des deux est vrai ... il [Dieu] peut créer et placer des intelligences où il veut.⁹⁵

⁹³ Ibid. [Mankind can wonder about his place in the universe when seeing that the most humble and the most looked down upon creatures exceed, through the miracle of their organization and of their instinct, the wonderful disposition of the overpraised human anatomy].

⁹⁴ Ibid. [The order of nature vanishes in the divine mystery].

⁹⁵ Réaumur, *Memoires*, 22. [Should we refute the fact that insects are intelligent, should we reduce them to simple machines? This is the main question of the “beats’ soul” that Mr. Descarte brought up a lot (...) it is impossible to prove which one is right (...) God places intelligence wherever he pleases].

While Descartes argued that insects – like all non-human animals – are only machines, some philosophers held that “les bêtes” had some intelligence and sensitivity.⁹⁶ Réaumur, by believing in insects’ intelligence, imposed changes in the Chain of Being, since their *instinct* – alongside the perfection of their physiology – created beings that he considered superior (in some ways) to mankind.⁹⁷ The study of insects was thought-provoking enough to lead philosophers and naturalists to examine and give perspective to their own relevance on Earth.

By considering Réaumur’s definition of insects, one realizes that insects do not easily fit within traditional taxonomical formulas. Indeed, Réaumur offered an odd definition of insects at the end of the introduction of his *Mémoires*: “la grandeur d’un animal ne doit pas suffir pour l’ôter du nombre des insectes.”⁹⁸ He concluded that crocodiles, reptiles, frogs, toads, and lizards – and even nettles and starfish – are as insect-like as a butterfly, a worm, a slug, or a spider. As delineated in the previous chapter, the microscope helped many naturalists to develop further knowledge in the field of entomology, and yet, the crocodile, which could be observed with the naked eye, still eluded classification. The traditional principles of the Great Chain of Being are put into question by this definition of insects, since bigger beings are reduced to the status of insects, or rather, insects are given the same rank and title as creatures that are multiple times

⁹⁶ Professor Matthew Lauzon, in the first chapter of his *Signs of light*, addresses the issues of communication and the hope for a perfect language, for an ideal speech, in the early modern period in England and France. Comparing Locke’s claim that animals are unable to form abstract ideas, therefore proving the superiority of humankind, other thinkers believed that, because animal language “was not subject to the ambiguity implicit in abstract words” (19-20) that it might be preferable to human’s way of interacting with one another. Using examples such as Marin Cureau de la Chambre who argued that “animal use the faculty of the imagination to reason and communicate” (20), John Webster who argued for a “language of nature” that mankind once knew but has forgotten, therefore proving that animal’s language is closer to that natural language (26). Another example he uses is Hobbes who also believe that human language became corrupted and prone to dispute, whereas animals can communicate without the art of words”, that is, without anything that could be twisted and understood in different ways, there are no plays with signs and signifiers (30).

⁹⁷ The topic of *l’âme des bêtes* was an important controversy at this time, too important perhaps to be studied more profoundly in this chapter.

⁹⁸ Réaumur, *Mémoires*, 58. [the height of an animal is not a sufficient criterion to decide whether or not a living being is an insect].

bigger. Though size was not the only element that naturalists took into consideration when organizing beings (for instance, humans were ranked higher than elephants), it did play an important part, hence why Réaumur's definition shattered his contemporary taxonomical ideas.

Lovejoy's three principles of the Great Chain of Being – the concepts of plenitude, continuity, and gradation – are of the utmost importance since Réaumur, though believing in a greater force that organizes the natural world, was influenced by those principles. As Réaumur realized that insects were problematic and did not fit into strict categorization theories, he modified traditional principles so that insects could fit in taxonomical conceptions of the natural world.⁹⁹ According to Roger,

il [le savant] se trouve maintenant pris au dépourvu par ces êtres étonnants qui n'ont rien de commun avec l'homme, par les animaux microscopiques, par les admirables insectes. Il se voit obligé de prendre Dieu au sérieux (...) ou de se réfugier dans des positions philosophiques résolument étrangères aux découvertes de la science¹⁰⁰

Réaumur opted for the first of the two options proposed by Roger in that he considered a God who created and ruled over the natural world. However, not of all Réaumur's contemporaries chose to do as such: to compare Réaumur's paradigm inspired by insects to one of his contemporaries', I will analyze one of Denis Diderot's (1713-1784) most famous texts, *Le Rêve de d'Alembert* in which he also adapted the contemporary taxonomical rules of his time to fit his own understanding of the world, and even went as far as removing divinity from the organization

⁹⁹ See Bougeant, *Amusement philosophique sur le langage des bêtes*, 1739, p.121: "et comme il y a quelques espèces d'insectes en qui nous remarquons plus d'industrie et de connoissance que dans de grands animaux, il est à croire aue ces espèces ont aussi un langage plus parfait à proportion, quoique toujours bornés aux besoins de la vie" [and as there as other species of insects in which we find more industry and knowledge than in animals of greater size, it is to believe that these species also have a language proportionally more perfect, yet still staked by the need to live].

¹⁰⁰ Roger, *Les Sciences*, 445. [However, the naturalist is now taken by surprise by these surprising beings that have nothing to do with human being, by microscopic animals, by admirable insects. He is urged to take God seriously, or to find shelter in philosophical position that would be firmly unfamiliar to scientific discoveries].

of the Chain of Being. However, before diving into the details of Diderot's understanding of the natural world, it is necessary to understand the early principles of the Chain of Being as they were described by Aristotle.

3) The original principles in Aristotle's *History of Animals* and the idea of zoophytes

In the eighth book of his *History of Animals*, Aristotle defined this concept as follows:

Nature proceeds from the inanimate to the animals by such small steps that, because of the continuity, we fail to see to which side the boundary and the middle between them belongs. For first after the inanimate kind of things is the plant kind, and among these one differs from another in seeming to have more share of life; but the whole kind in comparison with the other bodies appears more or less animate, while in comparison with the animal kind it appears inanimate.¹⁰¹

Aristotle summarized the main ideas of the Great Chain of Being, but rather than using goodness as a criterion (as Lovejoy defines the Chain), he used creatures' share of life, their animating force, to give them their rank in the world. His paradigm envisioned a world gradually organized in a continuous spectrum, from lifeless beings to living beings. Lines of demarcation between different beings are impossible to define. Because of the difficulty of finding a system that encompasses all categories of beings, classification was not a simple task, especially when understanding the relationship that certain creatures have with one another. Criteria for differentiating between species can – and will – vary, therefore creating different classifications and organizations of the natural world. Evaluating a singular species according to two different taxonomical criteria can lead to two different natural relationships and final rankings. According to Lovejoy, it is *because* lines of demarcation between species are impossible to find in

¹⁰¹ Aristotle, et al. *History of Animals*, Book VIII (Cambridge, Mass.: 1991), 61-63.

Aristotle's paradigm that taxonomical theories are able to find order in the natural world, as Lovejoy explained:

Nevertheless, any division of creatures with reference to some one determinate attribute manifestly gave rise to a linear series of classes. And such a series (...) tends to show a shading-off of the properties of one class into those of the next rather than a sharp-cut distinction between them, Nature refuses to conform to our craving for clear lines of demarcation; she loves twilight zones, where forms abide which, if they are to be classified at all, must be assigned to two classes at once¹⁰²

Lovejoy described the Chain of Being as being linear and vertical, but transitions between species do not occur abruptly. Rather, there is a fading effect due to the ambiguity of classifying certain species which – according to Aristotle – do not fall into neat categories. This fading effect is the reason why this theory uses the metaphor of a chain or a ladder to depict its taxonomical laws. However, as J.S. Spink expressed in his article *L'échelle des êtres et des valeurs dans l'œuvre de Diderot*, the difference between the term 'scale,' from the latin 'scala naturae' used by Aristotle, and the term 'chain,' used by Lovejoy, is the fact that the latter "met l'accent sur un aspect de la conception que l'autre ne met pas en évidence, à savoir la continuité."¹⁰³ This concept of the 'Chain' of being helps Lovejoy's take on the principle of gradation: though Aristotle explained that beings in his paradigm were continuous, the metaphor of the ladder implies a void between each rung, making it impossible to have smooth transitioning from one being to another one. To be sure, a ladder has space in-between each of its rungs, while a chain's links actually touch one another. By using Aristotle's definition of gradation, but by using a different terminology and a different metaphor, Lovejoy implies that the Chain of Being is more fluid than Aristotle's 'scala naturae'.

¹⁰² Ibid., 56.

¹⁰³ M. J. S. Spink, *L'échelle des êtres et des valeurs dans l'œuvre de Diderot*. In: *Cahiers de l'Association internationale des études françaises*, 1961, n°13. P.343. [emphasizes one aspect of this paradigm that the other one does not, that is to say the principle of continuity].

Whether it creates a segmented scale or a more fluid chain, not being able to define exactly what a certain animal or a plant is, and therefore allowing this being to be part of two different kingdoms, creates an imaginary space in which beings are not at a fixed place in nature, which therefore challenges Aristotle's principles. Indeed, if we are to consider his three principles, there should not be any doubt about the order of the natural world. Although Aristotle did recognize the fact that some species are at the boundary of the plant and animal kingdoms, and therefore are part of both, how can these beings be ranked inside this 'imaginary space of non-categorized beings' knowing that every being should have its distinct place? At the boundary of two kingdoms, this lack of clear definition leaves room for interpretation, imagination, and subjectivity. For instance, Aristotle observed that "For some of those [beings] in the sea might raise for one the question whether they are animal or plant (...) the body of some has a nature that is fleshlike (...) but the sponge in every respect resembles the plant."¹⁰⁴ Despite this characterization in the first book of *The History of Animals*, he considered sponges to be stationary animals endowed with some sensibility.¹⁰⁵ Susannah Gibson defines beings that are at the intersection of two kingdoms as "a group of strange creatures that existed somewhere on, or between, the boundaries of the plant and animal kingdoms" and refers to them as zoophytes, the category for beings that cannot be categorized.¹⁰⁶ Her examples include sponges, corals, starfish, earthworms and polyps. She also states that "it was in the eighteenth century, following the discoveries of Abraham Trembley, that larger numbers of naturalists began to study them [zoophytes] and to see them as potentially useful in answering big questions about the natural world."¹⁰⁷ Trembley (1710-1784) was a naturalist who is best known for his study on

¹⁰⁴ Aristotle, et al. *History of Animals*, Book VIII, 63-65.

¹⁰⁵ Aristotle, et al. *History of Animals*, Book I (Cambridge, Mass., 1991), Book I.

¹⁰⁶ Gibson, *Animal, Vegetable, Mineral?*, 44.

¹⁰⁷ *Ibid.*, 45.

the polyp, a curious living being found in water. Was it his discovery that changed naturalists' mind about the study of insects? What made the naturalists realize that insects were as worthy of study as beings of greater size?

In 1740, Trembley stated: "J'ai fait une découverte tout à fait extraordinaire : le polype classé par Leewenhoeck en 1703 dans le règne vegetal se trouvait avoir des caractéristiques animals dans son comportement."¹⁰⁸ The polyp, which used to be considered a plant, also proved to have animal features and therefore belongs to the category of zoophytes. However, other naturalists and historians understood the polyp in a slightly different way: for instance, Roger states that the polyp is an "animal étrange et minuscule qui se reproduisait à la manière des plantes,"¹⁰⁹ while May Spangler writes that Charles Bonnet "arrive à la conclusion que le polype représente le chaînon manquant entre les règnes animal et vegetal, et La Mettrie à sa suite lui donne l'appellation "Plante Animale.""¹¹⁰ According to these definitions, is a polyp an animal with some features of a plant or a plant with a few key features of an animal? Can it be both at once? If so, is it both equally? Natural philosophers tried to make the polyp fit inside their own paradigm and taxonomical rules, but as a result, the definition of what a polyp *was* became disorienting. This chapter's focus is on the understandings of these minuscule living beings, using the principles of the Great Chain of Being established by Aristotle. The difficulty of classifying zoophytes raises many epistemological questions, and, as I demonstrate, found an explanation in poetry, that is, fiction, hypothesis, thought experiment, and in texts that are hybrids between science and literature. It was necessary to first understand Aristotle's ideas – as

¹⁰⁸ May Spangler, "Science, philosophie et littérature : le polype de Diderot," *Recherches sur Diderot et sur l'Encyclopédie*, no. 23 (1997): 90. [He made an extraordinary discovery: the polyp, previously classified as a plant in 1703 by Leuwenhoek, happened to have animal's characteristics]. His methods of observations and his tools (namely his microscope) have not been accepted by everyone. Naturalists of his time were skeptical about his discoveries. For further information, see Roger, *Les Sciences*, 192-193.

¹⁰⁹ Roger, *Les Sciences*, 394. [a strange animal that reproduces just like plants do].

¹¹⁰ Spangler, "Science," 90.

well as Diderot's contemporary understanding of what zoophytes were – to understand how the history of taxonomical categorization evolved.

4) Diderot's materialism in *Le Rêve de d'Alembert*

In the eighteenth century, natural philosophers wanted to take part in the scientific debate surrounding taxonomical systems, and wanted to shed light on their own interpretation of the natural world. One of the most prominent philosophers of that time, Denis Diderot, editor of the *Encyclopédie*, held that, in order to understand the natural world, naturalists should look at living beings' composition, at the minuscule living 'animalcules' which formed the larger, visible body. This school of thought, called materialism, believed that everything was made out of sensitive, thinking matter that shaped itself in various ways. No outside power was responsible for this matter's development and history. Diderot, who wrote the article "Animal" of the *Encyclopédie*, repeated the principles of gradation and continuity through metaphorical language, writing that "le ruban célèbre du Pere Castel Jésuite, où de nuance en nuance on passe du blanc au noir sans s'en appercevoir," becomes a metaphor for the fact that "il nous sera bien difficile de fixer les deux limites entre lesquelles l'animalité (...) commence & finit."¹¹¹ Later in the definition, Diderot blames naturalists and philosophers for trying to give rules and laws to the world when nature is too complex to be defined this way. He argued that people cannot assume the presence of dividing lines in nature since "il y a des êtres qui ne sont ni animaux, ni

¹¹¹ *Encyclopédie, ou dictionnaire raisonné des sciences, des arts et des métiers*, Eds. Denis Diderot and Jean le Rond d'Alembert, ARTFL *Encyclopédie Project*, Ed. Robert Morrissey (Chicago: University of Chicago, n.d.) <http://encyclopedia.uchicago.edu/>, Vol. 1: 468. Definition of "Animal". [Like the Jesuit Father Castel's famous ribbon in which, from nuances to nuances, one goes from white to black without even realizing it] – [it will be very difficult for us to define limits in-between which the animal kingdom starts and ends].

végétaux, ni minéraux.”¹¹² Creatures that cannot be categorized served Diderot’s materialism philosophy, as will be demonstrated through an analysis of *Le Rêve de d’Alembert* (1769).

According to Wilda Anderson’s *Diderot’s Dream*, *Le Rêve de d’Alembert* is “often said to be Diderot’s most coherent statement of his materialist philosophy.”¹¹³ This philosophy preaches that it is a universal matter is what composes everything in the natural world. Interestingly, the polyp, a historically unclassifiable being, played a major part in this worldview. The idea of the classification of species in Diderot’s paradigm is quite a delicate task *because* of his materialist ideas: *Le Rêve de d’Alembert* is a philosophical treatise written as a play whose characters are the sleep-talking mathematician d’Alembert, salon holder Mademoiselle de Lespinasse, and Bordeu, a contemporary doctor. In this play, d’Alembert is dreaming and is talking out loud about what he sees, which gives material for the other characters to develop ideas about the natural world. d’Alembert’s dream is full of uncertainties and questions and, from the beginning of the text, it is possible to see that he is in a full philosophical reflection with himself as he corrects himself and challenges the foundations of his own thought when he says: “Un point vivant ... non, je me trompe. Rien d’abord, puis un point vivant...”¹¹⁴ d’Alembert, in this fiction, slowly progresses towards an acceptance of Diderot’s ideas on materialism.

At the time of the writing of *Le Rêve de d’Alembert*, religion advocated a duality between the body and the mind: the body was a perishable corporeal envelop for an immaterial and transcendent mind. On the other hand, for Diderot, *everything* is material, and this distinction between body and mind is not possible since the spirit would also be made of matter. As

¹¹² *Ibid.* Vol. 1: 469. Definition of “Animal”. [there are beings that are neither animal, nor plant, nor mineral].

¹¹³ Wilda C. Anderson, *Diderot’s Dream* (Baltimore: Johns Hopkins University Press, 1990), 42.

¹¹⁴ Denis Diderot, *Le Rêve de d’Alembert* (Version numérique du site internet ARTFL-FRANTEXT de l’université de Chicago) § 287-288. [A living point ... no, I am wrong. Nothing first, then a living point ...] When quoting from this novel, I will be using paragraphs’ numbers instead of pages.

Anderson writes: “Diderot refused this [mind-body] distinction.”¹¹⁵ Diderot's materialism was in opposition to the contemporary *doxa* about the natural world, as it contradicted people's widespread ways of understanding. It was necessary to understand Aristotle's ideas – as well as Diderot's contemporary understanding of what zoophytes were – to understand how the history of taxonomical categorization evolved. Diderot did not believe in the existence of God, or would rather consider a force in the world that creates movement, sensations, and transforms matter in a non-hierarchical manner. Diderot's universal matter changes: it assembles and juxtaposes itself to create an infinity of monstrous beings, whether this amalgamation be physical or physiological.¹¹⁶ Paula Findlen, in *Possessing Nature: Museums, Collecting, and Scientific Culture in Early Modern Italy*, defines the term ‘monster’ as “wonders of nature” with an “unusual anatomy.”¹¹⁷ In her understanding of the term, one is allowed to use the word ‘monster’ when analyzing Diderot's materialistic paradigm. Although the fundamentale matter is the same, creatures evolve differently: “Le faisceau de fils constitue la différence originelle et première de toutes les espèces d'animaux. Les variétés du faisceau d'une espèce font toutes les variétés monstrueuses de cette espèce.”¹¹⁸ The way that matter assembles itself creates beings, but this process never happens twice in the exact same way, therefore creating an infinity of different monsters within one same species. If Aristotle considered all creatures as being equal to one another so long as they belong to the same species, his idea of the Great Chain of Being could

¹¹⁵ Anderson, *Diderot's Dream*, 61. For another analysis on the mind, particularly when considering insects, see also Kate E. Tunstall article “The Early Modern Embodied Mind and the Entomological Imaginary.” *Mind, Body, Motion, Matter: Eighteenth-Century British and French Literary Perspectives*

¹¹⁶ Monster does not carry the bad connotation that it can have (for more information about this, see the fifth chapter of Daston Park's *Wonders and the Order of Nature*. Monsters are beings that cannot be classified within taxonomical system and therefore are a source of questioning, research, and discoveries.

¹¹⁷ Paula Findlen, *Possessing Nature: Museums, Collecting, and Scientific Culture in Early Modern Italy*. (University of California Press, 1994). 21.

¹¹⁸ Diderot, *Le Rêve de d'Alembert*, § 328. [The bundle of threads constitutes the original and primary difference of all species of animals. The varieties of the bundle of a species make all the monstrous varieties of this species].

not work in Diderot's materialist world. For Diderot, matter created every being uniquely, and even after naturalists organized species in a linear and hierarchical way, there were – even *within* species – differences to take into consideration to organize the natural world.

Diderot posited that, “tout animal est plus ou moins homme; tout minéral est plus ou moins plante; toute plante est plus ou moins animale. Il n'y a rien de précis en nature... Toute chose est plus ou moins une chose quelconque.”¹¹⁹ Unlike Aristotle's paradigm in which a species occupies only one possible rung – fixed and immutable – Diderot's worldview did not give monsters a specific position, as every being is composed by more or less of every kingdom. For Aristotle, there are different kingdoms, and only a few species fall in the category of the zoophytes, living beings that are not classifiable. In Diderot's system, every being falls within all the kingdoms. It is moreover impossible to organize Diderot's creatures in a linear and fixed scale since their composition, and therefore their existence with respect to the rest of nature is constantly changing. It is difficult, perhaps impossible, to create a hierarchical classification in this Diderotian world, since matter, the primary and only component of the natural world, is changing and unpredictable. Consequently, Aristotle's task to organize the world in a linear and gradual way is questioned here, or as Andrew Curran puts it: “far from being a part of a binary taxonomy organized according to genus and species, humanity and its monsters are members of an uninterrupted, classification defying Chain of Being.”¹²⁰ This idea of a ‘classification defying’ Chain of Being as defined by Aristotle was one of the result of the study of the smallest beings of the natural world. Their newly discovered bodies, physiologies, mechanisms, and perfection led naturalists to rethink the order of the natural system. Moreover, some of these small beings

¹¹⁹ Ibid., § 311. [Every animal is more or less a human being, every mineral is more or less a plant, and every plant is more or less an animal. There is nothing fixed in nature... Everything is more or less something].

¹²⁰ Andrew S. Curran, *Sublime Disorder: Physical Monstrosity in Diderot's Universe* (Oxford: Voltaire Foundation, 2001), 107.

proved to have particular properties that fascinated philosophers, as will be shown in the analysis of Diderot's *Le Rêve de d'Alembert*.

5) The polyp in *Le Rêve de d'Alembert*, a tiny creature with great implications

How does one understand a life form that displays characteristics of many kingdoms at once? How does one understand monsters? How can we understand their composition and how can we study matter in its most simple form?¹²¹ Diderot's interest in studying the invisible composition of beings was a way to find these answers. Diderot was fascinated by Trembley's research on the polyp. Before writing his *Le Rêve de d'Alembert*, he was familiar with polyps and their significance in taxonomical theories. In his definition of "Animal" in the *Encyclopédie*, Diderot brings up the in-betweenness or hybridity of the polyp as a plant-animal zoophyte, as well as its unique properties. What preoccupied thinkers about the polyp, according to Spangler, is that they could "le décapiter, lui mutiler les bras, le couper en morceau (...) il en resort toujours entier, vivant, en état de se reproduire."¹²² These strange behaviors enabled Diderot to extrapolate his materialist ideas.

Diderot did not stop there, speculating that human beings could also be separated as one did a polyp:

L'homme se résolvant en une infinité d'hommes atomiques qu'on renferme entre des feuilles de papier comme des oeufs d'insectes qui filent leurs coques, qui restent un certain temps en chrysalides, qui percent leurs coques et qui

¹²¹ Simply put, I mean that zoophytes are composed of less matter than bigger beings, the matter is less developed in those beings. It is therefore easier to study matter in what can be called its "original" stage before it starts to develop into beings of greater size.

¹²² Spangler, "Science," 89. [behead it, mutilate its arms, cut it into pieces (...) it'll always come out alive, ready to reproduce].

s'échappent en papillons, une société d'hommes formée, une province entière peuplée des débris d'un seul, cela est tout à fait agréable à imaginer...¹²³

Diderot describes a sort of polypous man: a man made out of men. This description also recalls a similar statement in his 1753 *Pensées sur l'interprétation de la nature* that “un homme n'est pas une machine.”¹²⁴ The machine is, according to the *Dictionnaire de l'Académie*: “[Un c]ertain assemblage de ressorts dont le mouvement & l'effet se termine en luy-mesme. *L'horloge est une belle machine. les automates sont des machines fort ingénieuses.*”¹²⁵ Machines are artifices created by humans, and as such it is possible to understand a machine, to repair it, and to see the different parts that compose it. This is impossible in Diderot's paradigm: humans are composed of animalcules, and the possibilities of assembling them are indefinite, as are explanations of how they are connected to one another. Humankind, according to Diderot's theory, is not composed of machines, but of monsters. Insects, categorized as monsters, could here take on a more positive, productive value. The fact that they could not be understood, rightfully observed, or ranked in the world made them all the more interesting and useful to Diderot.

Indeed, Diderot used insects in order to explain through a metaphor his material world, as he demonstrated how a swarm of different bees formed a single and singular, being. Yet, separating the bees from their swarm does not kill them, but rather creates individuals that live on their own – but who always have a relationship to the larger whole from which they came. The polyp, through a comparison with a swarm of insects, is therefore a way for Diderot not only to talk about his materialist ideas, but it also creates a dialogue where he can propose a solution –

¹²³ Diderot, *Le Rêve*, § 297

¹²⁴ Denis Diderot, *Pensées Sur L'interpretation De La Nature* (S.l.: n.p., 1754), 26. [a man is not a machine].

¹²⁵ *Dictionnaire de l'Académie*, article ‘machine’: “Machine: a certain assembly of springs, the movement and effect of which terminates in itself. The clock is a beautiful machine. The automata are very ingenious machines”.

a thought experiment – to questions of existence: Where does life come from?¹²⁶ What makes a being? What make a unit distinct from others? For instance, when the doctor Bordeu explains to Madame de Lespinasse that, when a bee is separated from its swarm, it is no longer one of the animalcules composing one being, but rather a whole new being altogether.¹²⁷

The discovery of the polyp moreover provided Diderot with the tools to think about matter differently. Diderot's world is inhabited by beings that *physiologically* are composed of the same matter that has been formed and combined in a new and unique way. These changes (or accidents of nature) happen every day, and the world of tomorrow will not be the same as yesterday's. Living beings change constantly, and mankind, also the product of an accident of nature, is prone to change. Mankind is no longer the pinnacle creation of God, but rather an unforeseen phenomenon of the natural world. The past cannot be used to understand the present, let alone to predict the future. The natural force that governs Diderot's worldview has no law: at least, no law that people – despite centuries of experience and observation of nature – have been able to enunciate.

As a result, Diderot asks: “qui sait les races d’animaux qui succéderont aux nôtres? [...] Le monde commence et finit sans cesse ; il est à chaque instant à son commencement et à sa fin ; il n’en a jamais eu d’autres, et n’en aura jamais d’autres.”¹²⁸ In this regard, perhaps should not be exemplified by the metaphor of a scale or a chain as it has historically been done by Aristotle or

¹²⁶ See Roger, *Les Sciences*, 614. [Le problème de la nature de la vie, de sa naissance et de son originalité, trouve dans ce texte [Le Rêve de d'Alembert] sa solution définitive]. [The problems of what is the nature of life, its birth and its originality, find a definitive solution in this text].

¹²⁷ Diderot, *Le Rêve de d'Alembert*, § 293. [Between this new state of the bee-group and the previous one, there is most certainly a distinctive difference, what else could it be but the fact that now it is a whole, one animal, while it was only a blend of animals before? (...) After? There are only distinct animals that the law of continuity holds in a sympathy, a unity, a general identity].

¹²⁸ Ibid., § 299-300. [Who knows the breeds of animals that will succeed our own? Everything changes, everything passes, and there is only the *all* that remains. The world endlessly begins and ends; it is at every instant at its beginning and at its end; there has never been another one, and never will be any other one].

Lovejoy, but rather by a comparison to a pearl necklace. In the Scale of Being, every being is defined by a rung, in the Chain of Being, they are represented by links. In my understanding of this “Necklace of Being,” each pearl would be the representation of living beings. In the Necklace of Being there is no gap between creatures. However, the advantage of the necklace is that every day, nature can make a new one, rearranging the pearls at will, thus creating an order in the world that differs from the previous one. Diderot studied nature through a materialist lens, and found a way to explain the complexity of nature in a less discordant manner than his contemporaries. His materialist philosophy allowed him to find some harmony in a world that has no laws and that rejects continuity. Because the possibility of monsters is infinite and because the world is constantly changing, Diderot's paradigm does not obey two of Aristotle's three principles, namely plenitude and continuity.¹²⁹ Even though living beings – according to Diderot – are made out of the same natural matter, their organization varies and therefore creates new creatures. The world, instead of being complete, is only partially whole: a work in constant process. If the living beings of tomorrow are unknown, it is because they do not yet exist in the world today, thus demonstrating a vacuum in the chain. This vacuum is theoretical and hypothetical, produced by Diderot's thought experiment, and it opens up the study and imagination of nature to his readers, inviting them into the process of creation. Through the study of the polyp and its strange properties, Diderot creates a materialist world that does not obey the taxonomical rules shared among his contemporaries.

This analysis of *Le Rêve de d'Alembert* proves that the study of tiny creatures had an impact on the ideas of the eighteenth century. From Trembley's close observations of polyps, to Diderot's materialism, naturalists showed an interest in ‘seeing,’ or ‘inventing’ through a thought

¹²⁹ See Roger, *Les Sciences*, 448. [la découverte, sans cesse poursuivie de la nature, fait s'évanouir toujours d'avantage l'ordre dont on affirmait l'existence]. [The never-ending discoveries in nature kept making the order of nature that philosophers believed in vanish].

experiment, the invisible and in deciphering the natural world in its component parts. In the field of entomology, the quest for truth and knowledge was at the core of different paradigms – whether they be religious or taxonomical. The study of polyps made Diderot and some of his contemporaries ask about taxonomical rules, and explore the possibility of *l'âme des bêtes* – that is – that beings are gifted with a soul. Indeed, being able to see and observe these creatures opened doors to re-interpreting how to see the world. The world is teeming with uncountable species of insects, naturalists used to discover new species all the time, and so do biologists still in the twenty-first century. Insects are a fascinating source of natural and philosophical thoughts, and eighteenth century natural philosophers were at the heart of the progress of the field of entomology.

6) Michelet, or a continuity of the Great Chain of Being

Both Diderot and Réaumur, by studying insects and smaller living beings, shed light on taxonomical laws and how restrictive they were. Diderot used insects as proof of his materialist philosophy, while for his contemporary Réaumur they were proof of a higher force ruling over the natural world. Despite their different ways of understanding insects, their interpretations challenged taxonomical rules in their own ways. A greater focus on the study of small creatures provoked questions and theories that could be best answered through poetic language. With these perspectives on how to study, understand, and extrapolate from insects in the eighteenth century, it is reasonable to wonder how philosophers and naturalists from the nineteenth and twentieth century understood them. Did they consider Diderot, Réaumur, and their contemporaries? Did

they combine the Enlightenment understandings of insects with their own reality, and did they have to also use a fictional discourse? Or did they reject these ideas as a way to dissociate themselves from what was natural history and to invent a new discipline called biology?

Even though Lovejoy argued that the idea of the Great Chain of Being stopped after the eighteenth century, this idea was still present in literature and science afterward. Indeed, the study of entomology developed in the nineteenth and twentieth centuries: the literature of entomology in this period echoed of the thoughts of those in the eighteenth century. Michelet's *L'insecte* (1858), in that regard, includes in his own understanding of insects philosophical thoughts from previous centuries: just as naturalists previously tackled the idea of zoophytes (or animalcules), the ideas of the Great Chain of Being (and its disruptions), as well as the debate about whether matter was ensouled come to the fore in Michelet's work.

In his introduction, Michelet described going to Lucerne in the Swiss Alps where he installed his office and his microscope. After walking in the surrounding forests, he decided that "ce qui jusqu'à ce jour fut un amusement [les insectes], une curiosité, une étude, dès lors fut un livre."¹³⁰ When Michelet wrote that "Chaque insecte est un petit monde habité par des insectes. Et ceux-ci en contiennent d'autres,"¹³¹ it is easy to see how this idea relates to Diderot's *Le Rêve de d'Alembert* and his ideas of matter and zoophytes. Just like the hypothetical man composed of tiny men described by Diderot in his philosophical treaty, Michelet framed insects in a similar manner, seeing them as beings composed of tinier living animalcules. Michelet stated that "Dans les masses que nous avons crues minérales et inorganiques, on nous montre des animaux dont il

¹³⁰ Jules Michelet, *L'insecte*. (Paris: L. Hachette, 1858), XXIII. [what was up until now an entertainment [insects], a curiosity, a study, became a book].

¹³¹ Ibid., IV. [Each insect is its own world inhabited by other insects. And those insects are also made out of insects].

faudrait mille millions pour arriver à la grosseur d'un pouce.”¹³² Not only are living beings composed of smaller living subsets, but things thought to be dead are in fact alive and composed of living animalcules. Observing what he calls “l'infini vivant” is a way in which we can discover new things about the natural world in order for us to understand it better.

Discovering living animalcules inside matter that was thought to be inorganic challenged the idea of the Great Chain of Being. Interestingly, Diderot also wrote about a similar idea, explaining to d'Alembert what he called the ‘experiment of Falconet’s statue’. This experiment consisted of destroying an inert statue made out of dead matter, then putting this “stone powder” into soil that will be used to grow food, and later to be digested by people. Through this thought experiment, dead matter is transformed into a living plant so that it can be absorbed by a human; indeed, this inorganic matter transformed into organic matter is capable of feeling and thinking. The idea that inorganic matter can turn into organic matter, or that what was thought to be dead happened to be alive challenged the theory of the Great Chain of Being.

Michelet categorized and gave order to beings and imposed his own taxonomical ideas on the natural world. In his first chapter entitled “Terreurs et répugnances d’un enfant,”¹³³ Michelet used a fragment of a family journal in which a woman recalls her childhood. After winter, when warmer days returned, her mother sent her and her brothers to their country house to pick fruit. There, she encountered insects and experienced an epiphany. She writes that “tous les êtres sont de Dieu” and that “Plus tard, mais bien plus tard, je compris les raisons de la Providence. L’homme absent, l’insecte doit prendre sa place pour que tout se passe (...), se

¹³² Ibid., V. [In the heaps of matter that we thought to be mineral and nonorganic, we now see animals of which we would need a billion to equate to the size of a thumb].

¹³³ [Dread and disgust of a child]

renouvelle ou se purifie.”¹³⁴ Michelet decided to stop this journal’s fragment right there. By cutting off the journal at this point, Michelet made the deliberate choice to expose and highlight the religious idea that every being is created by God and that insects and mankind are related.

When he writes “Les fourmis ont sur tous les insectes une supériorité, c’est qu’elles sont moins spécialisées par leur vie, leur nourriture et leurs instruments d’industrie. (...) Elles sont, pour ainsi dire, les factotums de la nature,”¹³⁵ I argue that he has the principles of the Great Chain of Being in mind. He prioritized ants over other insects, adding: “Elles [les fourmis] sont, dans ces contrées, reines et tyrans de tous les autres êtres.”¹³⁶ More than just ruling over insects, ants dominate every being they encounter, placing them being on top of the Chain of Being. Plants are invaded by insects invading them, trees are inhabited by anthills, and insects wage wars against other insects. Insects are omnipresent and omnipotent wherever they live. By reading *L’insecte*, it would appear that Michelet became fascinated by insects – and particularly by ants. At the end of the ninth chapter about his “muet homme de cuivre” (his microscope), he spends eight pages explaining and describing how wonderful and fascinating this experience of observing an ant was. The goal of this experience was to “interroger le visage de ce petit monde muet”¹³⁷ in order to discover the least trace of thoughts – or spirit – within them. If the eyes are the mirror to the soul, Michelet was hoping to find, through the observation of that ant’s face, a soul.

Michelet – just like Réaumur – believed in the idea that everything in the universe had a soul, or was endowed with degrees of the same divine presence. Michelet also brings this

¹³⁴ Ibid., 8. [every being is made by god] – [Later, way later, I understood God’s reasons. When mankind is absent, insect have to replace them so that everything can go on, (...) can be renewed or purified].

¹³⁵ Ibid, 243. [Ants are superior to all the other insects in that they are less specialized by their lives, their food, their industrial instrument (...) they are, so to speak, nature’s factotums].

¹³⁶ Ibid., 244. [Ants are, in this region, queens and tyrants of all the other beings].

¹³⁷ Ibid., 117. [interrogate the face of this tiny mute world].

expectation to the study of the ant under the microscope: “Ce masque fixe, immobile, condamné à ne rien dire, est-ce celui d’un monstre ou d’un spectre ? Non. D’après ses mouvements, et tant d’actes plus avancés que ceux des grands animaux, on est bien tenté de croire qu’en cette tête il y a quelqu’un (...) on sent l’identité de l’âme.”¹³⁸ Not only does he confirm ants’ place among the top rungs of the Chain of Being, he also states that ants act as if they had a soul. Just as Roger states, the study of insects “venait de montrer que ces recherches pouvaient poser les plus étonnants et les plus graves problèmes.”¹³⁹ The Great Chain of Being was not the only philosophical idea impacted by the study of insects. After the death of Réaumur, natural philosophers became more interested in taxonomical classification and that their attentions turned to bigger issues, “qui donnent à l’intelligence un objet jugé plus digne d’elle, et paraissent conduire plus directement à la connaissance de l’homme lui-même”¹⁴⁰ which is what contemporary author Bernard Werber focuses on in his writing.

In this context, how does modern science fiction tackle insects? Which of these two claims would they consider true? Do the principles of the Great Chain of Being remain true in modern literature? Are ideas developed centuries ago still relevant in modern science fiction – and if so – how are they portrayed?

7) Science fiction and Bernard Werber

¹³⁸ Ibid., 124. [This immobile mask, condemned to not say a thing, is this the one of a monster or of a ghost? No. According to its movements, et so many more acts that are more advanced than most of the other animals, one would be tempted to believe that there is someone in those heads (...) one feels the identity of a soul].

¹³⁹ Roger, *Les Sciences*, 750. [the field entomology just showed how it could ask the most surprising yet the most serious problems].

¹⁴⁰ Ibid., [that give to intelligence an object worthier of it, that seems to lead more directly to the knowledge of mankind itself].

Before examining contemporary science fiction, it is necessary to go back to Diderot's *Le Rêve de d'Alembert*, as there is an aspect of this work that we must not forget to analyze: its form. It is a philosophical treatise that takes place on multiple dream-levels, thus describing a world of fiction to illustrate the author's worldview. According to Kurt Ballstadt, "The Dream (...) has been frequently passed as a work of bold, imaginative, occasionally perceptive speculation,"¹⁴¹ while May Spangler qualifies *Le Rêve de d'Alembert* as a "spéculation scientifique," an "expérience imaginaire," and a "petite fable extraterrestre."¹⁴² *Le Rêve de d'Alembert* is a hypothesis and Diderot used scientific language and reasoning to experiment on ideas. It is a poetic experience which described Diderot's materialist paradigm. As stated earlier, zoophytes are at the crossroad of two different kingdoms: animal and plant. Diderot juxtaposes these two kingdoms in a text that is at the crossroad of two different disciplines: science and literature. These four paths meet at an intersection that allows Diderot to develop his theories about the natural world. Using science as a literary tool, Diderot applies literature as a way to express his scientific ideas, but ultimately, *Le Rêve de d'Alembert* is more than a representation of the materialist zenith of its author – it is a poetic and fictional representation of another world. Therefore, even though *Le Rêve de d'Alembert* does not belong to our modern definition of science fiction, it can be – and should be – considered as such.

In this light, Diderot's *Le Rêve de d'Alembert* not only was a way to tackle the idea of the Great Chain of Being through the philosophy of materialism, it also was a way to understand how fiction, literature, and science have been working in tandem for centuries. I will end this chapter with an analysis of Bernard Werber's *Les fourmis* and how he addresses the main concerns about the natural world seen in Diderot, Réaumur and Michelet. *Les fourmis* was

¹⁴¹ Kurt P. A. Ballstadt, *Diderot: Natural Philosopher* (Oxford: Voltaire Foundation, 2008), 159.

¹⁴² Spangler, "Science," 89, 92 and 93. [scientific speculation], [imaginary experience], [a little extraterrestrial tale].

Werber's first novel, published in 1991. That same year, the author was invited to participate on the French TV channel "Antenne 2" in a program called *Caractères*. While talking to the host Bernard Rapp, Werber explained the genesis of his novel: as a child, he was fascinated by the activity that was happening just under his feet and his fascination only grew stronger as the years passed. Werber once said: "la science-fiction est un peu en retard sur la fourmis, on dirait qu'on découvre chaque fois des choses qui existent chez les fourmis,"¹⁴³ referring to the society depicted in Aldous Huxley's *Brave New World* and the way ants procreate. In Huxley's fiction, giving birth to children is not biological anymore – rather, children are made inside a laboratory and their future is determined there in a scientific way. Similarly, the queen of the anthill, when giving birth to ants, knows exactly that she is giving birth to a soldier, a worker, a princess or a reproductive male: fiction and science *are* interconnected. The study of insects, and specifically of ants, influences mankind and our perception of the world, making insects some of the most fascinating living beings.

Insects are as fascinating as they are timeless. Indeed, throughout the centuries, insects brought up the same sort of questions and naturalists and philosophers responded with the knowledge and resources available at their time. How has Werber tackled the same questions that Réaumur, Diderot and Michelet pondered? The ideas of monsters and machines are both present in Werber's *Les fourmis*, but instead of being separated – as was the case in the eighteenth and nineteenth centuries – monsters and machines are combined. Indeed, in order to have access to the world of insects, Edmond Wells, one of the characters in Werber's work, created a machine in order to be able to communicate with them. He writes:

Mon oncle réfléchit encore longtemps et se dit que le meilleur moyen de communiquer était de fabriquer une « fourmi robot ». (...) Edmond l'a baptisé «

¹⁴³ <http://www.ina.fr/video/I10018902/bernard-werber-video.html> [Ants are ahead of science fiction, it seems like we always discover something that already exists among ants].

Docteur Livingstone ». Il est en plastique. Je ne vous dis pas le travail d'horloger qui a été nécessaire à la fabrication de ce petit chef-d'œuvre !¹⁴⁴

Ants are still monsters – or creatures in the cosmos that resist classification and are hard to understand – but they are also machines, that is human creations that can be explained and whose technological body is known ‘physiologically.’ Werber imagines a paradigm in which communication between two different worlds is possible thanks to a technological and minuscule ‘robot-ant’, that is, thanks to the development of knowledge.

For Werber, ants represent much more than just insects: he describes them in his book as “des êtres à part entière. Ce ne sont pas que des petits insectes de rien du tout (...) Les fourmis constituent la seconde grande civilisation terrienne.”¹⁴⁵ Werber adds nuances to the preconceived idea that most people have about insects. Insects are generally not assessed on their own terms because of their size. However, in *Les Fourmis*, Edmond Wells states:

*Qu'y a-t-il de plus beau qu'une fourmi ? Ses lignes sont courbes et épurées, son aérodynamisme parfait. Toute la carrosserie de l'insecte est étudiée pour que chaque membre s'emboîte parfaitement dans l'encoche prévue à cet effet. Chaque articulation est une merveille mécanique*¹⁴⁶

Only someone who spent some time studying entomology such as Werber would write such a praise of insects, using flattering words such as “beautiful,” “refined,” “perfect,” “perfectly,” or “wonder.” Werber creates an image of insects that is almost holy. The reader can easily picture an ant in its most perfect form. When Werber writes that the body of an ant has been studied so

¹⁴⁴ Bernard Werber, *Les Fourmis* (Paris: Albin Michel, 2010), 288. [My uncle kept thinking and told himself that the only way to communicate [with the ants] was to make a robot-ant. Edmond named it ‘Doctor Livingstone’. It is made out of plastic. This is the product of a watchmaker work! Only they have the necessary skills to complete such a masterpiece.]

¹⁴⁵ Werber, *Les Fourmis*, 281-282. [See, they are beings. Fully-fledged beings. They are not just little insignificant insects (...) Ants are the second biggest terrestrial civilization. As for Edmond, he is a sort of Christophe Colomb who discovers another continent right at our feet. He understood that, before looking for extraterrestrial life on the edge of space, it would be best suited to first to make a junction with ... intraterrestrial life].

¹⁴⁶ *Ibid.*, 102. [What is more beautiful than an ant? Its lines are curved and refined, its aerodynamism is perfect. The insect’s whole body has been studied so that each limb would perfectly fit in the notch made for this effect. Each articulation is a wonder of mechanics].

that it can reach perfection, one could argue: by whom? Who is the person or entity that is studying the insect? Indeed, who created them? Who engineered them? And what is perfection in this new hybrid model of the Chain?

Werber and Diderot share ideas: Werber states: “Il [Edmond] voulait comprendre la cellule à son stade le plus primaire. Pour lui, l’homme n’étant qu’un conglomerat de cellules, il fallait comprendre à fond la « psychologie » d’une cellule pour déduire le fonctionnement de l’ensemble.”¹⁴⁷ With thoughts close to Diderot’s ones on matter, Edmond Wells decides to study matter at its smallest size in order to be able to understand nature at its grandest. Matter and cells share common threads in both texts, and even if the terminology has changed, deeper questions remain. Where does life come from? Why do animals behave the way they do? What is the role of fiction in the way we understand the world today – that is – if it is ever used at all anymore? In this light, I do not agree with the idea that the Great Chain of Being is an idea that stopped at the end of the eighteenth century: the study of insects has always been a way to capture the essence of those questions, and their questions are still relevant nowadays to understand the natural world.

After understanding the main concepts of the Great Chain of Being and after analyzing one of Diderot’s major texts, it becomes clear that changes in taxonomical ideas and the understanding of insects are related. Even though it appears that the idea of the Great Chain of Being ‘stopped’ after the eighteenth century, I argue that texts that related to entomology afterward continue to be influenced by principles, authors, and natural philosophers who came before them. From Michelet’s *L’insecte* to Werber’s *Les fourmis*, ideas on matter, on *l’âme des bêtes*, and on the place of insects in contemporary taxonomical traditions are still relevant today.

¹⁴⁷ Ibid., 34. [He [Edmond] wanted to understand what a cell is at its most elementary stage. According to him, mankind being only a conglomerate of cells, we needed to fully understand the psychology of a cell to deduce how the whole being functions].

Indeed, ants – and insects in general – compel us to change our point of view on nature, suggesting different perspectives of it, and this is the reason why the field of entomology is so important to literary studies.

PERSPECTIVE(S)

Si un électron était doué de *conscience*, se douterait-il qu'il est inclus dans cet ensemble beaucoup plus vaste qu'est l'atome ? Un atome pourrait-il comprendre qu'il est inclus dans un ensemble beaucoup plus vaste, la molécule ? Et une molécule pourrait-elle comprendre qu'elle est enfermée dans un ensemble beaucoup plus vaste, par exemple une dent ? Et une dent pourrait-elle concevoir qu'elle fait partie d'une bouche humaine ?¹⁴⁸

1 – *L'Arbre des possibles* (The Tree of Possible Futures)

If a molecule were to be conscious of its own entity as a molecule, would it be aware of its functions as part of a whole macro-cosmos that itself belongs to an even greater universe? In a greater scale, would an insect be aware that it is part of a greater cosmos, and that it is only a small living being compared to, let us say, a cat?¹⁴⁹ In an even greater scale, would a bird know that up above the height limit it can reach there are stars and a whole greater unknown universe to be discovered? Through the use of an “if-then” clause in the quote above, Bernard Werber presents this theoretical thought experiment. If a molecule, an ant, or a bird, were conscious of its own existence, would it know that it is only a minuscule part of a greater world? However, when taken out of this context and applied to human beings, that is, living beings conscious of their own presence on Earth rather than non-thinking (or so we think) beings, this quote starts disentangling in interesting ways, especially because a thought experiment is deeply tied to human perspective and thought.

¹⁴⁸ Werber, Bernard. *Nouvelle Encyclopédie Du Savoir Relatif Et Absolu*. Librairie Générale Française, 2011. P.60. [If an electron had a *conscience*, would it realize that it is only a part of a larger whole that is the atom? And the atom, would it realize it is a part of a larger whole that is the molecule? And could a molecule understand that it is enclosed in a larger whole, for instance, a tooth? And that tooth, would it be able to conceive that it is only a part of a human mouth?]

¹⁴⁹ This idea directly ties to Fontenelle's one exposed in footnote 66 as he stated that a mite is itself an elephant to other tinier species.

This chapter will analyze the human consciousness of being present, through an analysis of Werber's *L'Arbre des possible*. The analysis of this concept will bring forth this idea of perspective using Pascal's *Pensées* and his ideas of *les deux infinis*, ideas that will shed a new light on texts by Réaumur, Michelet, and Werber. This will eventually finish with an analysis of Werber's work at the light of these ideas, which will be particularly relevant after having seen how the Enlightenment naturalists understood and used them.

In 1998, Bernard Werber published a novel entitled *Le Père de nos pères*. Revolving around the theory of the missing link in the great chain of evolution of mankind, this thriller is based on a journalistic investigation of the murderer of a scientist who claimed to have the answer to that scientific mystery. Two journalists, Isodore Katzenberg and Lucrèce Nemrod, are in charge of the investigation, and as the case moves along, the latter character reveals to the former what he has been creating: an "arbre de tous les futurs probables."¹⁵⁰ Depicted and drawn as a tree [*l'arbre des futurs*] whose branches are based on 'if-then' clauses, Lucrèce tries to imagine how the world would be, should this or that event happen – or not – in the near, medium, or distant future. This way of organizing thoughts and scenarios of the future helps to understand larger trends in different societies: "c'est du sort de toute l'humanité et même de tout ce qui vit sur cette planète qu'il s'agit. Il est grand temps de réfléchir [...] en tant qu'êtres vivants intégrés à tout un ensemble beaucoup plus vaste."¹⁵¹ Returning to the very first quote of this chapter, Werber expresses the fact that mankind is only a part included in a greater whole. Just as the human body needs every molecule to function properly so that it can itself function properly, people need to think and act, knowing that their actions have consequences on the greater world to which they belong. This idea will be analyzed in greater detailed in the second

¹⁵⁰ Werber, Bernard. *Le Père De Nos Pères*. Albin Michel, 1998. P.81. [tree of potential futures].

¹⁵¹ Ibid., 82.

part of this chapter, but for now, let us go back to the *arbre des futurs*. This idea of a theoretical tree outlined in Werber's *Le père de nos père* inspired him to publish a book four years later in which he continued to reflect upon the theoretical methodology of Lucrèce Nemrod: Werber made his very first anthology of possibilities of mankind's future scenarios come true.

Many philosophers and naturalists used trees as metaphors for more abstract metaphysical theories, ideas, and systems of knowledge. For instance, Diderot and d'Alembert's *Encyclopédie* was a way for philosophers and naturalists to organize all the knowledge and ways of knowing of their time. In order to advertise for the *Encyclopédie*, they published a prospectus in 1750 in which they wrote that their goal was to “former un arbre généalogique de toutes les sciences et de tous les arts, qui marquât l'origine de chaque branche de nos connaissances.”¹⁵² The editors pushed further the comparison to a natural tree when they stated that they wanted to “indiquer les liaisons éloignées ou prochaines des êtres qui composent la nature [...] de montrer par l'entrelacement des racines et par celui des branches, l'impossibilité de bien connaître quelques parties de ce tout, sans remonter ou descendre à beaucoup d'autres.”¹⁵³ The tree has the advantage to be built because deeply rooted in solid ground. With a firm trunk, its branches grow further and further away, becoming more and more meticulous and precise. In order to understand a branch, people have to understand where it lead, and from which branch it is coming from, until they arrive to the common trunk and roots. By tracing the making of ideas and knowledge, one could understand that the *Encyclopédie* proposed a way of thinking that would link everything in the natural world. This metaphor of a tree took the shape of two well-known organizational charts: the *Arbre généalogique* (figure 1) and the *Système figuré des*

¹⁵² <http://classes.bnf.fr/dossism/aprospec.htm> [to form a genealogical tree of all sciences and all arts that could mark the beginning of each branch of knowledge”].

¹⁵³ Ibid. [indicate the distant and close links between beings that are part of the natural world (...) to show through the intertwining of roots and branches the impossibility of knowing any parts of the whole world, without going back to many other things].

connaissances humaines (figure 2). The importance that lies behind the format of this tree shaped diagram is that, not only is the tree an easy way to organize knowledge, but it also implies possibilities for the future. Indeed, just as its biological counterpart, a tree of knowledge never stops growing, getting taller and wiser as time passes. There is no limit to how far a tree can grow, therefore no limit to how far human knowledge can go and to what people can achieve over time. The tree of knowledge, just as trees in the real material and natural world, is a work in progress that keeps growing as well as generating possibilities for future development.

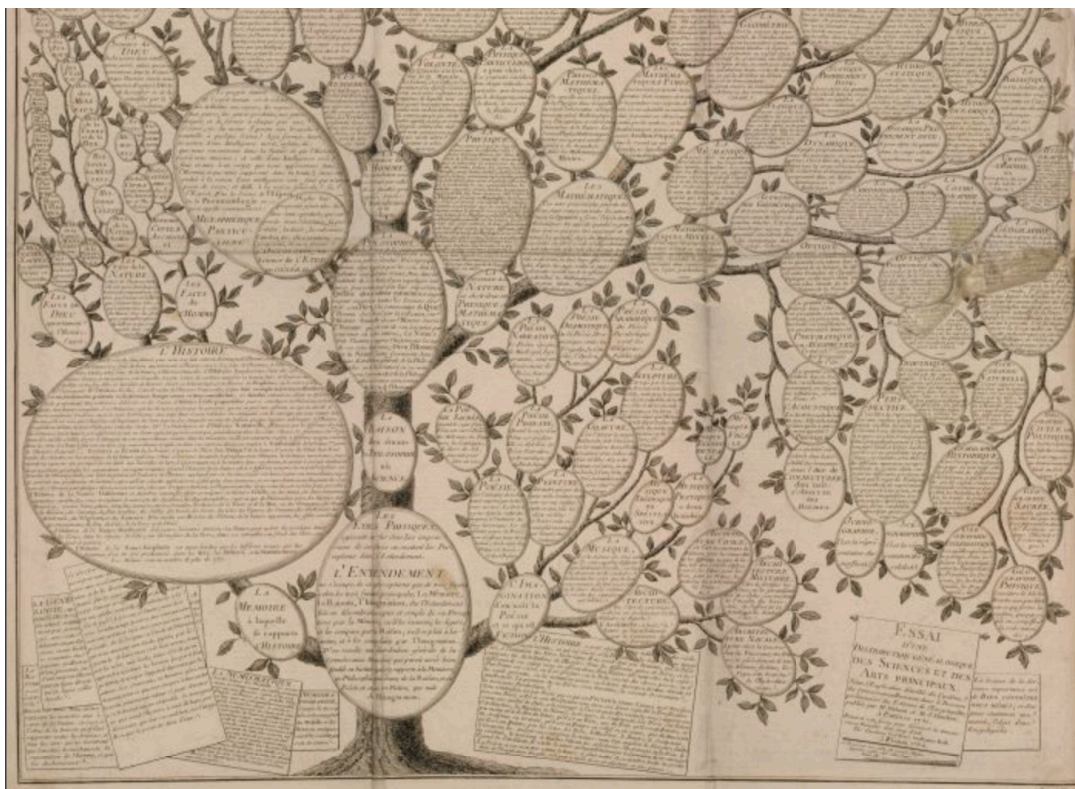
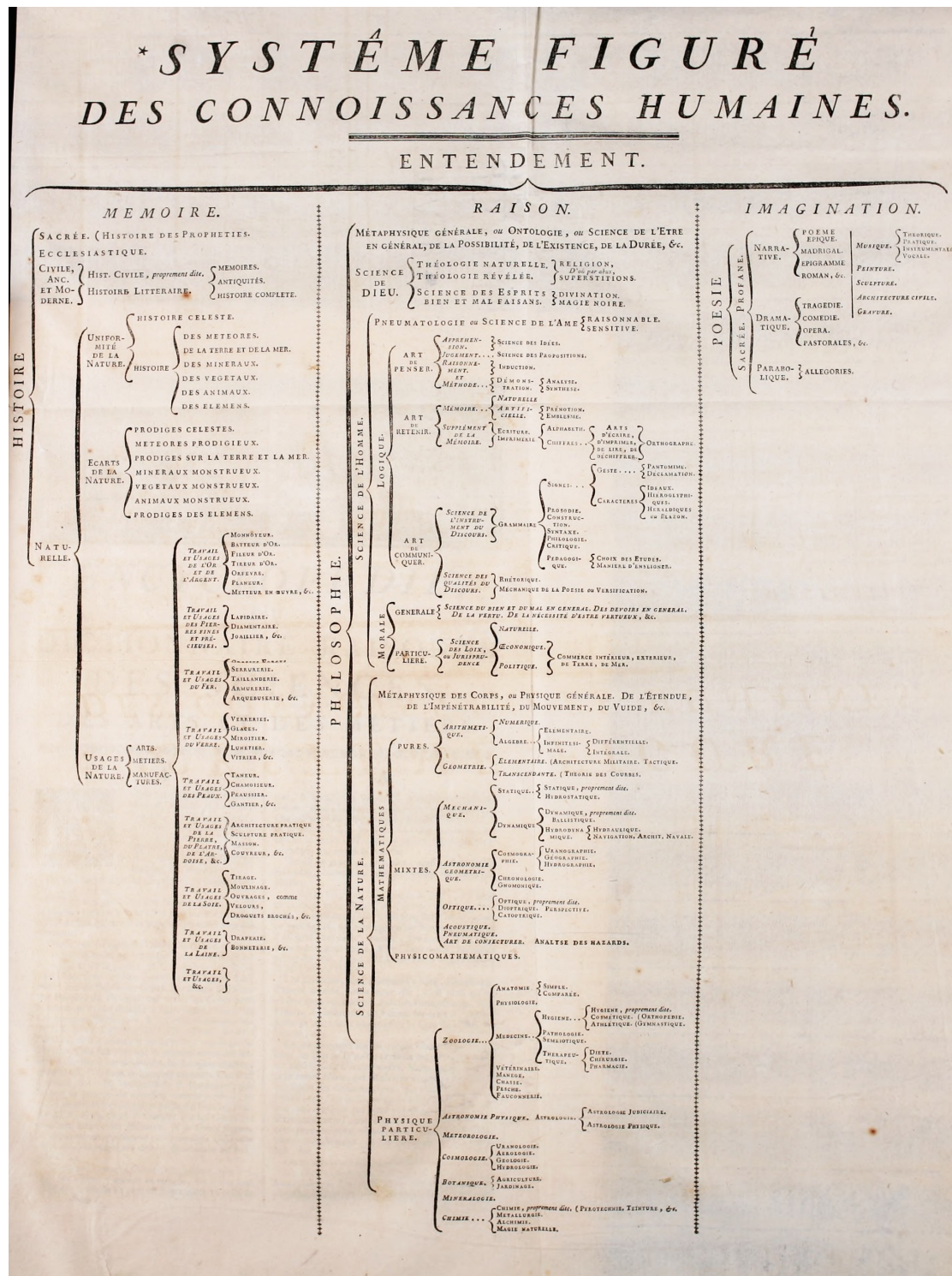


Figure 1: Genealogical tree in the *Encyclopédie*

<<https://encyclopedie.uchicago.edu/content/arbre-généalogique>>

Figure 2: *Système figuré des connaissances humaines* in the *Encyclopédie*

<<http://classes.bnf.fr/dossism/gc378.htm>>

The use of a tree as a metaphor for understanding the world was not unique to the Enlightenment. Descartes used it in the previous century. In his *Principes de la philosophie*, he wrote that “Toute la philosophie est comme un arbre, dont les racines sont la métaphysique, le tronc est la physique, et les branches qui sortent de ce tronc sont toutes les autres sciences qui se réduisent à trois principales, à savoir la médecine, la mécanique et la morale.”¹⁵⁴ Just as the encyclopedists used it a century later, Descartes’ tree of philosophy is also a way for him to organize knowledge to better understand the laws of the natural world. Descartes also knew that philosophy changed over time, that new branches were born from its trunk, and that new branches were to appear in the future. This organization tree was not only used in science and philosophy, but also in literature. In the nineteenth century, Emile Zola attempted, through his Rougon-Macquart series, to tie to his work the idea of heredity that was newly discovered at his time. This collection of twenty novels, each of them focusing around a family member of a family, was also organized through the use of a tree that would trace the hypothetical history of this family during the second empire in France. Manuel Lima, in *The Book of Trees*, traced how people used metaphors of trees to organize knowledge, and found that this tradition was as old as time. In this light Werber once again follows a tradition rooted in the past in order to understand his present.

As previously stated, the shape of a tree informs the development of knowledge and its organization, and implies future branches that need to be discovered, that is, the tree diagram pushes and urges for new knowledge in order to keep growing. The first branches in *L’Arbre des possibles* represent thought experiments that are based in the present day and are the product of

¹⁵⁴ Descartes, René. “Principes de la philosophie” in *Œuvres De Descartes*. (1897). P.14.
[The whole field of philosophy is like a tree whose roots are metaphysic and whose trunk is physics. Every branch that grow out of this trunk are other sciences that groups themselves in three main sciences: medicine, mechanics, and morals].

observations. The branches are based on if-then clauses, and themselves grow other branches that are potential outcomes and consequences of that ‘mother-branch,’ like a snowball effect. While other tree diagrams require only creativity when imagining what the next growing branch would be, Werber’s *Arbre des possibles* is entirely based on imagination and thought experiment.

Werber’s *L’Arbre des possibles* is a collection of twenty novels published in 2002. Each of these novels depicts a potential outcome for humanity, should current issues not be resolved or should an unexpected event happen: “Chacune de ces histoires présente une hypothèse poussée jusqu’à son extreme.”¹⁵⁵ Some of these hypotheses include, for instance, a meteorite that falls on the Luxembourg Garden in Paris, a scientist who discovers the secret of invisibility, a world in which objects are alive and talk, or trees that can intervene human decisions. Although most of these fictions are clearly impossible, conjectural literature allows Werber to explore worlds in which these claims are true, therefore enabling him to describe worlds with different natural laws. His main goal, through this book, is not to “predire l’avenir mais de designer les enchainements logiques d’évènements.”¹⁵⁶ Since Bernard Werber is neither a prophet nor an oracle, these novels are not to be read pragmatically or literally. On the contrary, people should understand the ideas behind the whole book, not behind each novel, and the way the author framed his ideas of potential futures, that is, to understand the importance of *L’Arbre des possibles* as a way of organizing the world and understanding what might lie beyond the present space and time. Werber is an author, trying to see what could happen using logic and literature as his medium.

¹⁵⁵ Werber, *L’Arbre*. P.11. [Each of these stories presents a hypothesis that have been pushed to a paroxysm.]

¹⁵⁶ Werber, Bernard. *L’Arbre Des Possibles Et Autres Histoires*. Albin Michel, 2002. P.74. [not to predict the future but to show the logical series of events].

During a Ted Talk in 2011, Bernard Werber explained his tree project: each branch or novel is a scenario of the future.¹⁵⁷ According to him, since the beginning of time, and particularly since people started planting crops, humans have been thinking about the future. In order to cope with the unknown created by those thoughts, various people took on the responsibility to predict and give shape to the future: shamans, priests, oracles, and artists. Though they all tried, he claimed, they all failed. In order to find their replacement, that is, to find who has the potential and the credential to see beyond the limits of the present to create future worlds, Werber used the metaphor of a chess game. When playing chess, both players think about the next move of their opponent in order to find the best retaliation; but what happens when someone plays against a computer? The artificial intelligence sees more possibilities than the humans do, and is therefore more likely to choose the best potential way for it to win: “la supériorité de l’ordinateur, c’est la masse de futur possible, et le fait qu’il ne juge pas, qu’il ne cherche pas tout le temps à trouver l’unique bon scénario. Il les évalue tous avec une certaine objectivité que nous n’arrivons pas à reproduire.”¹⁵⁸ Because people are subjective in the choices they make, they close doors because they know – or rather think they know – that the outcome is going to be bad. However, that same door could lead to different directions, one could say, unexpected directions. The computer, on the other hand, has the ability to consider every possible outcome, no matter how good or bad it might be. Acknowledging, in this regard, the power and the superiority of the machine compared to human intellectual power, Werber decided, about three weeks after the publication of his 2002 novel, to transform his literary tree of possible outcome for humanity into a technological tree, by creating an eponymous website.

¹⁵⁷ <http://www.bernardwerber.com/videos/videos.php?id=102&selection=bw>

¹⁵⁸ <http://www.bernardwerber.com/videos/videos.php?id=102&selection=bw> [the computer’s superiority is the importance of potential futures and the fact that it is objective when considering them: it analyses all of them without trying to look for the perfect one with a certain objectivity that we, human, cannot copy.]

To be sure, the *Arbre des possibles* is neither purely artificial intelligence nor purely human imagination; it is a combination of both at all times. The website organizes human imagination in a way that a computer would organize scenarios during a chess game; therefore, just as in a chess game, people should read these scenarios created by human imagination without subjectivity, the way a computer would read them. What differentiates this project and way of organizing these scenarios from other science fiction books is that usually, a book would pick one scenario and develop it, whereas the tree combines scenarios into a multitude of possible causal relationships, one leading to another one and so forth. The *Arbre* gives a greater perspective and understanding on how these scenarios connect to one another by combining human imagination and a computer 'way of thinking.' Bernard Werber imagined a platform where people use technology in order to escape their innate way of thinking, enabling them to see things from another perspective. Technology therefore becomes an enhancer of human imagination by wiring it differently.

The idea behind the website version of *L'Arbre des possibles* is indeed to transform human knowledge into an artificial intelligence online, just as the player-computer relation in a chess game. By organizing scenarios thematically in a database, the goal of this website is to lay out a multitude of potential futures for humanity in the near, medium, and distant future to which people will always be able to have access. The database should be read without subjectivity, that is, all scenarios should be all seen as being as possible unless proven otherwise by real events. By discarding scenarios and keeping those not proven wrong (yet), the ultimate goal would be to be guided towards the scenario that is the most likely to happen, in order to be best prepared for it. Those scenarios could also be seen as warnings of what not to do to not fail as a species on Earth (for instance, about pollution, or the use of nuclear weapons). With current threats

concerning global warming or nuclear attacks, the *Arbre des possibles* could be a place where scenarios of the future could be found, that is, where today's decisions will potentially lead us as a species in the future. Finally, one last potential use of this database is that it is a way to immortalize our current ways of thinking for later generations who would want to try to understand the cultural and intellectual histories of the 21st century, which, interestingly, was also one of the thoughts behind the *Encyclopédie*.

Before ending this part about the *Arbre des possibles*, it is relevant to look at the interface of the website, which might help to grasp the core goals of this futurology tool



Figure 3: main page of the website of *L'Arbre des possibles* presented via a spiderweb.

<http://www.arbredepossibles.com>

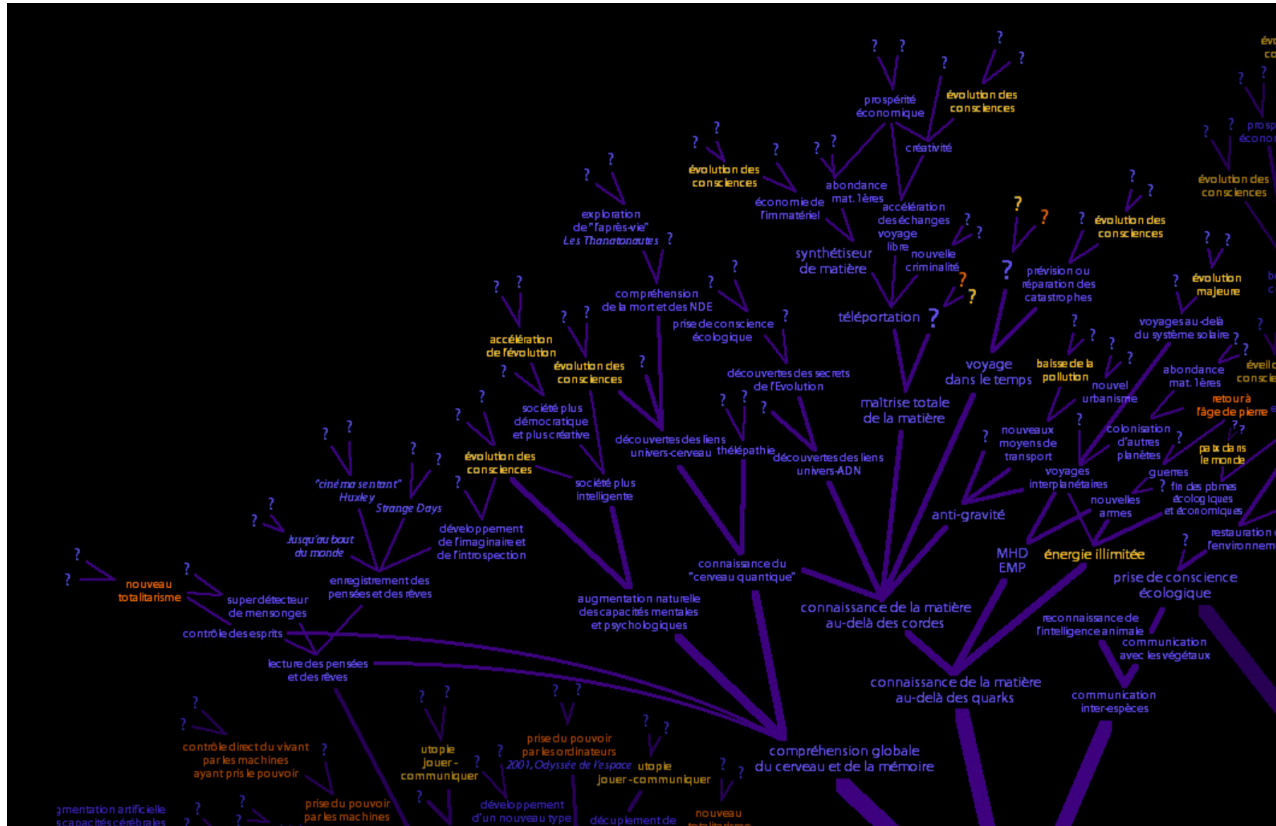


Figure 4: Close up on one of the tree's branches

<http://www.arbresdespossibles.com/FutursScience.html>

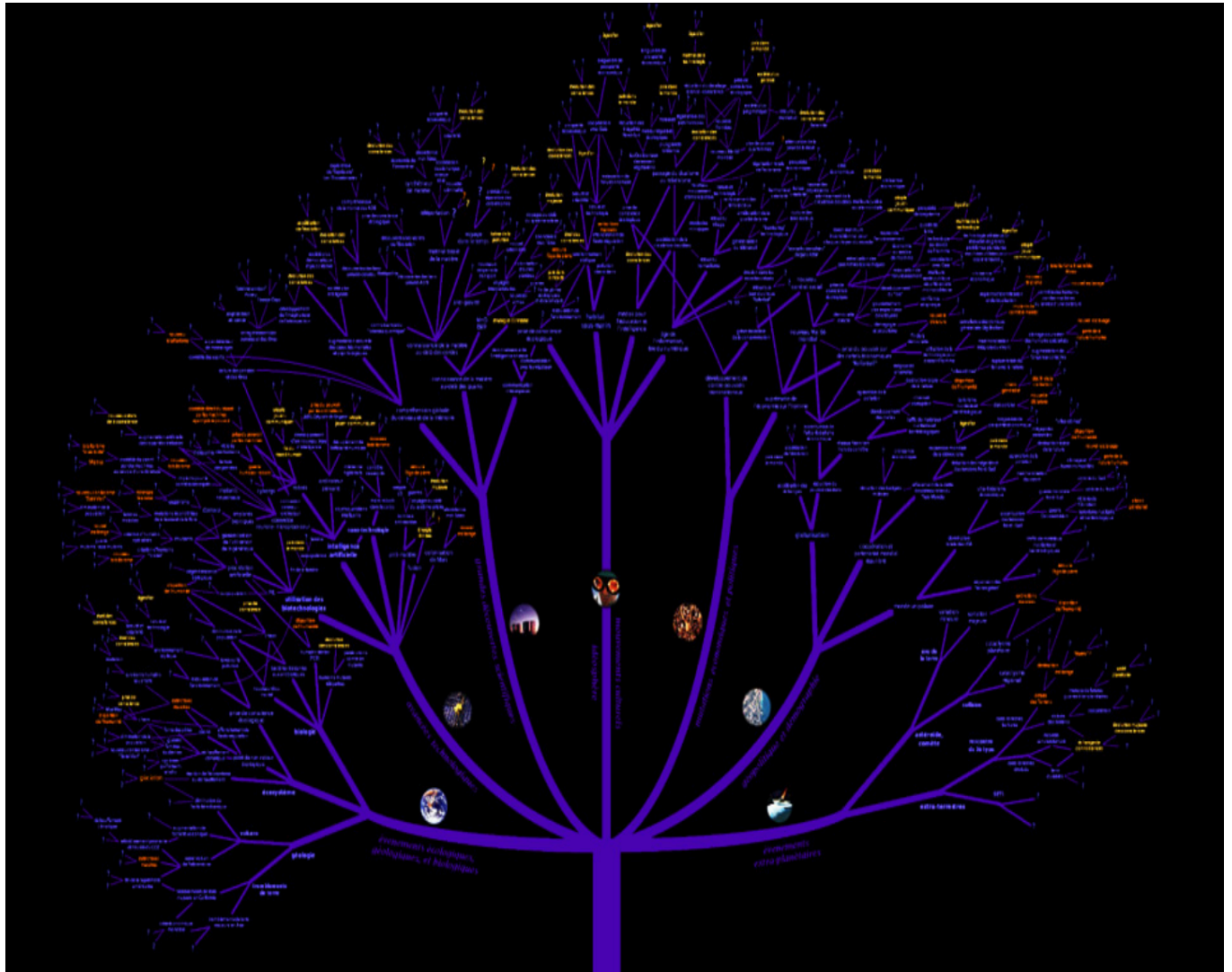


Figure 5: A representation of *L'Arbre des possibles* (here called La Carte des possibles)

<http://www.arbredespossibles.com/CarteDesFuturs.html>

As shown in figure 3, the tree is divided into seven main branches: ecological; biological and geological events; technological discoveries; scientific discoveries; new philosophies and cultural movements; economic and political mutations; geopolitical and demographical changes; and finally, extra-terrestrial events. Each branch is then divided into different sub-branches, as shown in figure 2. Each of these sub-branches represents a potential change in the main branch

from which it derives. Those sub-branches are then divided into other sub-branches (and so on) with three potential outcomes: either the sub-branch comes to an end after having found a solution (the first outcome being a good solution, in yellow, or the second one representing a bad solution, in orange), or, third outcome possible, the sub-branch hits the wall of the unknown and therefore would need further scenarios to disentangle the knot of that sub-branch.

Where do all these scenarios come from? Werber did not write these scenarios himself, but planted the seed of the tree by publishing his novel back in 2002 and by creating the website a few weeks afterwards. This website is indeed a collective project that uses fictions as its data: in this regard anyone can submit a short story that is his or her representation of a potential future for humanity based on an “if” clause: what would happen if we were able to control the anti-matter? If we were able to travel at the speed of light? If we colonized other planets? If we encountered other intelligent species in space?¹⁵⁹ By enlarging the authorship of this project, opening it to anyone with an idea of a scenario that has never been thought about before, the website collected a large amount of potential outcome for humanity (as of January 28th 2018, the number of published scenarios is 9221). This idea of collective thinking to find an answer is not new to the author. During his childhood, Werber noted, while observing ants, that

Dans la fourmilière, il n’y a pas de CV, il n’y a pas de diplôme, il n’y a pas de spécialistes c’est en permanence la recherche du meilleur scénario et n’importe quel individu, qu’il soit jeune, qu’il soit vieux, qu’il ait déjà fait des erreurs ou qu’il ait déjà réussi après, peut présenter son idée à l’ensemble de communauté, il ne sera jugé que sur l’originalité de l’idée et sur la faisabilité de cette idée.¹⁶⁰

¹⁵⁹ All of those scenarios have been developed on in the section of the website that focuses on “scientific discoveries” scenarios. See figure 5.

¹⁶⁰ Werber, Bernard. *TedXParis 2011 – L’Arbre des possibles*, 06/03/2018.

<<http://www.bernardwerber.com/videos/videos.php?id=102&selection=bw>> [In the anthill, there are no CVs, no diplomas, no specialists, it is a constant research for the best scenario, and whoever, whether they be young, old, if they have already made mistakes or succeeded, can present their ideas to the whole community. This idea is only judged based on its feasibility and its originality].

Ants are seemingly on the constant search the best scenario that could happen. Through a collective way of thinking, insects share experiences, ideas, and as a whole, decide which solution is the best fitted for the situation at hand.

Peter Bentley focused on insects in the fifth chapter of his book *Digital Biology: How Nature Is Transforming Our Technology and Our Lives*. Starting his chapter with a fictional story about ants, Bentley explained how ants organize themselves and are in a sense ‘intelligent’ beings.¹⁶¹ Observing how insects interact with each other and how a whole nest communicates inspired computer science engineers to create programs that operate in the same way. These programs are more precisely called “distributed artificial intelligence,”¹⁶² and they mirror the way an ants’ nest functions. Even more, computer science engineers invented a new sub-field called “ant colony optimization.”¹⁶³ After observing how fast insects were to find the shortest paths to food, Marco Dorigo “used digital ants in his computer to solve traveling salesman problems,”¹⁶⁴ creating a program that would try every way possible to find the shortest route to food. Ants have been on earth for 120 million years, while mankind has been present for only seven million years and this is why we, as humans, have a lot to learn from the world of insects.

As Bernard Werber writes:

longtemps on a pensé que l’informatique en général et les programmes d’intelligence artificielle en particulier allaient mélanger et présenter sous des angles neufs les concepts humains. Mais même en la présentant différemment, la matière première reste identique : des idées produites par des imaginations

¹⁶¹ Though “intelligent” might not be the most appropriated word, it is one with the most epistemological relevance: what is intelligence? it is only human? can intelligence exist within other species and could they be compared to one another? Alan Turing asked these questions in *Computing machinery and intelligence* in which he compares artificial and human intelligence. His famous test asks people to determine whether or not their interlocutor is a machine or another fellow human in order to see if artificial intelligence could pass (or be greater) than the human’s one.

¹⁶² Peter Bentley, *Digital Biology: How Nature Is Transforming Our Technology and Our Lives* (Simon & Schuster, 2010), p.118.

¹⁶³ Ibid., 122.

¹⁶⁴ Ibid., 124.

humaines. C'est une impasse. La meilleure voie pour renouveler la pensée est de sortir de l'imagination humaine¹⁶⁵

Rather than creating an artificial intelligence that mimics human ways of thinking, people should start thinking differently, in a non-human way. Dorigo, by creating an artificial intelligence that thinks like an ant allowed them to have a voice and developed their way of thinking that differs from ours. He projected ants' 'brains' onto our world to construct an artificial intelligence that would create ant-like thought experiments, and therefore allows creative thinking and a different way of understanding problems that impact us. This entanglement of different intelligences depends upon, and tests the limit of all of its components, human and insect. In this light, insects bring new perspectives to technology, as well as a fresh a new way of wiring information and of thinking about the world.

In this light, *L'Arbre des possibles*, whether the novel or the website, is a human interpretation of the way ants think, just as the field of distributed artificial intelligence does. *L'Arbre des possible* provides humans with a model for thought and improvement that is not, in fact, human. Werber, by writing *L'Arbe des possibles* and by creating the eponymous website wanted to deconstruct humankind's way of thinking by rewiring it the way a computer or an ant thinks: by having as many equally potential scenarios as possible. By basing his ideas on non-human way of thinking, whether it be computer-based or ant-based, Werber leaves human imagination to find new possibilities of re-organizing that same human imagination. As he stated, it is only by doing so that we, humans, can change our ways of thinking. Leaving our usual mindset allows for new, interesting models for human thought such as the ones Werber

¹⁶⁵ Werber, *Les Fourmis*, 262. [for a long time, we thought that computer science in general along artificial intelligence programs would mix up and present would shed new lights on our human thoughts. But even through shedding new lights upon them, the raw material is still the same: ideas conceived by human imagination. This is a dead-end. The best way to renew our thoughts is to quit human imagination].

proposes, which are distinctly not human: insects provide a way into a world of fictional possibilities, developing a new definition and form of creativity. We would not traditionally call insect, hive behaviour, or computer systems, creative, but Werber shows how they are important to understand in a literary domain: they give us new perspectives and corresponding discourses through which to think about ourselves.

After understanding the theoretical concept behind *L'Arbre des possibles*, its main goals, and the way in which it is currently being used online, the general principle that surrounds this concept is the one of perspective: *L'Arbre des possibles* sheds light on what shape the world would take following a series of potential scenarios, therefore giving perspective on humankind and its potential futures. Yet, the idea of perspective was at first a mathematical and geometrical tool used to imagine the shape an object would take from a different angle – all depending on the hypothetical position of the viewer, and it is interesting to see how this notion transferred from the mathematical field to a literary one.

2 – Pascal's *deux infinis*

Bernard Werber has always been aware of the possibilities that the tool of perspective could open. As a child, he preferred to stay by himself at his grandparents' house rather than going to summer camp. Lying in the garden, he observed living creatures around him. While lizards or toads ran away, ants would stay and let themselves be observed.¹⁶⁶ These experiences were most probably an inspiration for his very first novel, entitled *Les aventures d'une puce* [*The Adventures of a Flea*] written at the age of seven, in which Werber tells the story of a flea from its point of view. Completely lost in the human body, the flea attempts to explore and discover

¹⁶⁶ Youtube video – French TV show – Parenthèse inatendue.

where it is before being fatally crushed by a finger. Through this six-page story, Werber found a way of writing that he would use in many of his novels. According to him, “Utiliser le regard d’êtres différents pour parler de nous, les humains, m’a toujours semblé intéressant. C’est une source inépuisable de réflexion (dans tous les sens du terme).”¹⁶⁷ For the author, using an unexpected point of view urges people to think about themselves; to reflect upon a reflection transposed into words of fiction. By seeing themselves from a whole new point of view, people are prone to think about themselves differently; in perspective. From an ant’s point of view throughout his first trilogy, Werber then observed humans through a broader perspective in *l’Empire des anges*:

L’idée de *l’Empire des Anges* est de réfléchir sur *les points de vue exotiques*. *Les Fourmis* donnaient le point de vue des fourmis, donc de l’infiniment bas. Dans *l’Empire des Anges*, on dispose du point de vue des anges, donc de l’infiniment haut. Cela permet de présenter la vie des hommes et les mécanismes des destins avec une distance inaccoutumée¹⁶⁸

As an author, Werber is looking for new ways to see and understand the human species, and therefore needs to use a different perspective. Using humans as the core of his thought experiments, Werber places them in a certain scenario, under a certain microscope (or macroscope) and puts words into what come to his imagination when pondering upon the setting he decided to use. Through these “unusual distances” that humans have from the ant or the angel, Werber directs an “exotic point of view” on humankind and allows people to think about themselves in a different perspective. While exotic means something that comes from far away,

¹⁶⁷ Werber, Bernard. *L’Arbre des possibles Et Autres Histoires*. Albin Michel, 2008. P.10. [Using the eyes of another being to write about mankind has always been interesting to me. It is an inexhaustible source of reflection (in all meanings of the term).]

¹⁶⁸ Werber, Bernard. Biographie. <http://www.bernardwerber.com/bio/biographie_plus.php> (27 novembre 2017) [The idea behind *L’Empire des Anges* is to reflect upon exotic points of view. *The Empire of the Ants* gave the point of view of an ant, that is the infinitely small. In *L’Empire des Anges*, we have the point of view of angels, that is the infinitely large. This allows the representation of mankind and the mechanism of destiny with an unaccustomed distance.]

it is also to be understood as unexpected, different, unusual. The way Werber uses perspective reveals his idea that humankind needs to step outside of human imagination to renew that same human imagination. Just as Dorigo created an ant-inspired artificial intelligence that would help people by allowing them to think differently, these unexpected literary ways of seeing ourselves gives room for interpretation and self-reflection.

Interestingly, the fact that Werber uses the terms ‘infinitely small’ and ‘infinitely large’ is noteworthy, as it is without a doubt linked to Pascal’s idea of the “two infinities” that he explains and expands on in his *Pensées*. In order to better understand and define what ‘perspective’ is, I am going to bring the chapter back to its very first quote and to the idea of proportion. These two ideas are going to be analyzed and understood in a literary work, that is through Pascal’s idea of the *deux infinis* in his *Pensées*. Pascal argued that it is conceited for people to believe that they can understand nature, for nature is infinite. Stuck between what he called the ‘infinitely small’ and the ‘infinitely large,’ people are in no position to really understand the marvelous of their surrounding world, and are particularly not apt to understand what lies beyond: “Tout ce monde visible n'est qu'un trait imperceptible dans l'ample sein de la nature. Nulle idée n'en approche, nous avons beau enfler nos conceptions au delà des espaces imaginables, nous n'enfantons que des atomes au prix de la réalité des choses.”¹⁶⁹ The visible world is nothing but a small part of the whole cosmos: the study of insects is only a tiny understanding of what lies beyond the visible. Interestingly, Pascal used an insect to illustrate his ideas metaphorically, when he explained how in a mite (“un ciron” in the French version) one could find

¹⁶⁹ Pascal, Blaise, 1623-1662. *Pensées sur la religion, et sur quelques autres sujets*. Paris, Ed. du Luxembourg, 1952. (Chicago: University of Chicago, n.d.) <http://artfl-project.uchicago.edu/content/artfl-frantext> p.137. [All this visible world is only an imperceptible feature of a whole wider world. No idea gets close to understanding it, even though we inflate our conceptions beyond the imaginable space, we only bring into the world atoms at the price of actual reality.]

des jambes avec des jointures, des veines dans ses jambes, du sang dans ses veines, des humeurs dans ce sang, des gouttes dans ses humeurs, des vapeurs dans ces gouttes, que divisant encore ces dernières choses il [l'homme] épuise ses forces en ces conceptions et que le dernier objet où il peut arriver soit maintenant celui de notre discours.¹⁷⁰

This gradation, like a Russian doll, recalls Werber's quote that introduced this chapter and gives the impression of an endless road stretching from large to small, where there is always going to be something to discover further down in the miniscule world of atoms.

Interestingly, as Pascal wrote, the only possible guide to that endless road is language – and yet, language and discourse are innately subjective interpretations of the world. People use language to share their subjective experiences of the world, experiences that are always understood differently according to people's point of view. Language, in this regard, becomes a human tool to express people's relativity to other things. In a larger perspective of language, literature is a tool that helps humans to explain the world, to make sense of the unknown that consistently surrounds them. In other words, languages, literature, and discourse are tools used to invent another perspective to find our place in the larger world; they become measuring tools that allow people to explore the unfamiliarity of the world to eventually obtain a better understanding of it.

When Pascal wrote that people could 'inflate their conceptions beyond the imaginable space,' this implies that their conceptions entered a world of fiction in order to understand the natural world, in a place beyond the natural world. What was the 'imaginable space' to which Pascal was referring? In my understanding of Pascal's *Pensées*, this space is a world of thought experiment and hypotheses. In this light, the understanding of the mite resonates with the study

¹⁷⁰ Pascal, Blaise, 1623-1662. *Pensées sur la religion, et sur quelques autres sujets*. Paris, Ed. du Luxembourg, 1952. (Chicago: University of Chicago, n.d.) <http://artfl-project.uchicago.edu/content/artfl-franxtext> p.135. [limbs with their joints, veins in the limbs, blood in the veins, humours in the blood, drops in the humours, vapours in the drops. Dividing these last things again, let him [the man] exhausts his powers of conception, and let the last object at which he can arrive be now that of our discourse].

of the polyp as depicted in Diderot's *Le Rêve de d'Alembert* which has been analyzed in the previous chapter, as there seem to be no end to the marvel both creatures contain, and to the productivity of language that people use to talk about these living beings. As a reminder, eighteenth-century naturalists were fascinated by the polyp's physical ability to survive even when they mutilated it. Just like the astonishment produced by the dissection of a polyp or the understanding of a swarm of bees, the mite is a portal to leads towards a fictional world and discourse. Insects act as a gate between the natural world and a fictional imaginative space in which ideas explaining the former world are created.

3 – Bernard Werber, or the continuity of the Enlightenment

The idea of two infinite worlds above and beneath the visible world is a recurrent question and theme in modern science fiction, particularly the quest to find other intelligent being in greater space. For Bernard Werber, this dichotomy will be analyzed in *Les Fourmis*, where scientific knowledge is used not to find intelligent beings in greater space, but on the contrary in the depths of Earth.¹⁷¹ At multiple times throughout the novel, Werber brings out the idea that everything is relative when it comes to size: something is always bigger – or smaller – than something else that they might not even be able to see because of the disproportion in size between them. Knowing this, it is understandable that using fiction to describe insects is a way to talk about humankind and its place on Earth. Poetic discourse on insects is a way to talk about perspective and how, perhaps, humankind is relatively minuscule in the greater order of being.

¹⁷¹ Werber wrote: “Il [Edmond Wells] a compris qu’avant de chercher des extraterrestres aux confins de l’espace, il convenait d’abord de faire la junction avec les... intraterrestres” (281-282) – [He [Edmond Wells] understood that before looking for extraterrestrial life in outer space, mankind should first create bridges with ... intraterrestrial life].

However, I have been using a modern understanding of what perspective is in order to understand its use in literature. As I claimed in the previous section, Werber willingly used terms that linked him directly to Pascal's notions and ideas, and understanding this link sheds new light on his novels and his underlying messages. Knowing this, the purpose of this third and final part is to demonstrate that we can also understand how Werber uses perspective in his novel through a consideration of past understanding of this concept, especially by having Enlightenment naturalists' ideas and concepts in mind.

One of the most intriguing definitions of perspective, and yet, one that is still relevant today, is the one given by the *Encyclopédie*, since it states that perspective is either speculative or practical:

La *spéculative* est la théorie des différentes apparences ou représentations de certains objets, suivant les différentes positions de l'œil qui le regarde.
La *pratique* est la méthode de représenter ce qui paroît à nos yeux ou ce que notre imagination conçoit, & de le représenter sous une forme semblable aux objets que nous voyons¹⁷²

Speculative perspective involves theorizing; it is thinking about the shape of an object using theoretical logic and the rules of delineating abstraction of space. On the other hand, practical perspective is the act of representing what our eyes and our imagination see in a way that resembles the real world. Just as the definition of *merveilleux* in the *Encyclopédie*, practical perspective creates an illusion of reality after the information has been processed through the eyes and imagination of the viewer. This definition of perspective indeed conflates “ce qui paraît à nos yeux” and “ce que notre imagination conçoit”—the order we see in the world and the order

¹⁷² ARTFL, *Encyclopédie*, 12:433 n.a. [The speculative perspective is the theory of the different representation of certain object, according to the different position of the observing eye. The practical perspective is the method of representation of what is before our eyes or what our imagination conceives in a way that is similar to the objects that we see.]

we imagine in our minds—as discourses that strive to be “semblable aux objets que nous voyons,” that is, to resemble a real order in the world.

The process of developing perspective therefore happens in two different steps: starting with a speculative approach, the viewers produce conjectures and hypothesis – a sort of thought experiment – to figure out how an object would look like, should the position of the viewer change. Using not only their sight, but also their imagination, they create a mental picture of how an object would look like from a different angle. While the object itself is real, thinking about an object in perspective is the product of one’s imagination and therefore lies in an imaginary world: it is a hypothesis of a shape. The second step of the process is to find a physical way to draw that mental image, the hypothesis of shape produced by one’s thought experiment, in the real world. As a reminder from chapter one, Voltaire defined imagination not as a creative force, but as the ability to re-form images of objects in the real world in one’s mind. Therefore, the process of perspective uses the real world to create imaginative and fictional representation of them that does not lie in the real world. It is because hypothesis and imagination are part of the mathematical understanding of what perspective is, that its use is relevant in literature: mathematical perspective and literary perspective both rely upon the same human senses, that is, the power of imagination, of being able to create a thought experiment to see things differently.

To analyze how this statement works, let us go back to the naturalists’ texts that have been analyzed throughout the first two chapters. Even though their terminologies used to write about this concept of perspective differ, all of the authors that have been studied in this thesis are very much alike in their understanding of the main issues of perspective: Pascal, Réaumur, Michelet, and Werber share a metaphysical common ground in a world of ideas through the prism of insects. They also share common understandings of proportion and relativity: in order

for something to be big, something else has to be smaller. Conversely, for something to be considered small, something else has to be large. Nothing can be evaluated for what it is worth on its own, as it has to be relative to something else: nothing is absolute, and every critical judgement on size is the product of comparison. Since a person only sees the world from one point of view, it can be challenging to see things in perspective. Indeed, as Pascal writes:

Si l'homme s'étudiait le premier il verrait combien il est incapable de passer outre. Comment se pourrait-il qu'une partie connût le tout ? Mais il aspirera peut-être à connaître au moins les parties avec lesquelles il a de la proportion. Mais les parties du monde ont toutes un tel rapport et un tel enchaînement l'une avec l'autre que je crois impossible de connaître l'une sans l'autre et sans le tout.¹⁷³

To this, Werber replies, centuries later:

*(...) toutes les choses, petites et grandes, répondent aux mêmes lois et connaissent les mêmes liens d'interdépendance. Par exemple, vous qui tournez cette page [de ce livre], vous frottez en un point votre index contre la cellulose du papier. De ce contact naît un échauffement infime. Rapporté dans l'infiniment petit (...) cette particule est en fait, « relativement » à elle-même, immense.*¹⁷⁴

Both writers express the relationship of people to other parts, living and non-living, of the world.

While relativity means being unable to escape this perspective, unable to see from above, these authors work to turn this into a productive feature of human perspective. Moreover, while perspective is fixed in that it follows a certain set of rules, relativity is based upon the human mind that mentally relates two different components. Because relativity and perspective are two intricate and related concepts, problems arise. Going back to chapter two, where I considered the

¹⁷³ Pascal, *Pensées*, 137. [If, in the first place, mankind were to study itself, it would see how much it is not capable of thinking beyond itself. How could it be that a part of a whole could understand the latter? Perhaps it would try to understand things with which it has some proportion. But all the parts of the world are linked to one another such as there is an order in which they go one after the other, and I believe it is impossible to know one without the other and without the whole.]

¹⁷⁴ Werber, *Les Fourmis*, 52. Everything, small or big, all obey to the same laws and know the same interdependence. For instance, you who is turning this page [of the book], you rub at one point your index against the cellulose of the paper. This contact creates a minuscule heating. This latter, in the context of a the greatly small, provokes the jump of an electron that leaves its atom and bump into another atom. This latter is, actually, relatively to itself, gigantic.]

Great Chain of Being, using perspective means having a natural order that originates with God as the highest rung. When, however, people started to use relativity between beings, especially when considering insects, the preconceived natural order was shattered. Thus, every being belongs to the same natural world and is subject to the same laws, the only difference is the scale upon which those events are taking place. Both writers also explicitly state the fact that everything is relative to something else, especially that every minuscule creature is composed of tinier components that are themselves made of even tinier components. Conversely, this would also mean that mankind is part of a larger whole, and that mankind – even the world as we know it – could be a hypothetical component of a larger amalgamation of parts.

Half a century after the publication of the *Pensées*, Réaumur also understood ideas of perspective and proportion in a similar way, stating in his *Mémoires* that “le grand et le petit ne sont que quelque chose que par rapport à nous, pour que les structures des insectes imperceptibles ne parussent pas plus admirables que celles de ces masses animées de grandeur colossale.”¹⁷⁵ According to Réaumur, it is because sometimes points of view when considering nature – and especially insects – are so disproportionate with human perspective of the world that marvel is created. It is because of that disproportion between nature and people that our languages act as bridges to try to reach truth in the unknown.

In the nineteenth century, Michelet, after reading naturalists’ works for three years to prepare for his work *L’Oiseau*, came across many references to insects that would help him in writing his book about them. Indeed, while working on *L’Oiseau*, he discovered a passion for insects that led him to write a second natural science-inspired book, *L’Insecte*. *L’Oiseau* and *L’Insecte* are two metaphors that represent the two extremes of the spectrum: “Hier, je donnai

¹⁷⁵ Réaumur, *Mémoires*, 30. [the tall and the small must be things that are only relative to ourselves, for that the structures of imperceptible insects do not seem more admirable than the one of humongous creatures].

l’oiseau, élan du cœur vers la lumière. Aujourd’hui, la même force me mène au contraire dans la grande mer vivante des métamorphoses.”¹⁷⁶ If the birds embody the light, then insects represent darkness: they are the infinite sea of the invisible in which entomologists get lost. Birds fly high above while insects sink into the dark abyss of death and metamorphosis, and yet, Michelet seemed to be more fascinated by these tiny creatures than by birds. For Michelet, and for Werber decades later, observing and studying insects leads to seeing and understanding “leurs étranges et surprenants modes d’action, comme on ferait des habitants d’une autre planète, par miracle apportés ici.”¹⁷⁷ Michelet was aware that the study of insects could bring a different perspective to the natural sciences – he even writes that the ant he was studying must have seen him like a horrible giant – and this was probably one of the reasons why he was so fascinated by insects. Unlike birds, insects are easy to find as they are crawling and buzzing everywhere, but also unlike birds, the difficulty of observing insects raises more philosophical and existential questions than birds do. Insects are only understood relative to something else, not in and of themselves. Insects and fiction, when combined, create an illusion of another universe unrelated to ours.

Thinking about how an object would look, should the position of the viewer change, is an important tool when studying science fiction. Perspective is a powerful literary and philosophical tool: as Werber explains himself, science fiction writers do a work of projection before writing a story since “la fonction d’un auteur de science-fiction remplace la fonction d’astrologue, de chamane, de directeur de plan quinquennal” in other words, those who have the responsibility to

¹⁷⁶ Michelet, *L’insecte*, 44. [Yesterday, I gave *L’Oiseau*, a jump towards the light. Today, the same force brings me, on the opposite side, in the big sea of living metamorphosis.]

¹⁷⁷ Ibid., 159.

see beyond the present.¹⁷⁸ Perspective is part of the technology of a novel, one of the devices that helps produce sense and creates imaginary worlds. This recalls the discussion of the *Arbre des possibles* and computer intelligence discussed in the beginning, as they both motivate creativity and imagination. The *Arbre* needs imagination to keep growing, while computer science, with regards to the distributed artificial intelligence field, invents ants' ways of thinking to push human imagination further. The diagram of the tree, following an ant's thought, allows a greater perspective on the human species and its future; the tree becomes a language that tells stories of future possibilities, stories of perspective. Language, whether used to depict perspective, imagination, or the marvelous, serves as a tool for Werber, Michelet, Réaumur, and for all the other naturalists, philosophers, and authors mentioned in this thesis. Language helps them to describe the invisible, it serves as a techno-literary tool which, just as the microscope did in the seventeenth and eighteenth centuries, helped naturalists get a better understanding of insects: language is a literary technology that helps to make sense of the unknown.

¹⁷⁸ <http://www.iris-ic.com/bernard-werber-science-fiction-permet-partager-mes-intuitions-du-futur/> [the function of a science fiction author replaces the one that astrologers, shamans, and directors of quinquennial plans once had.]

CONCLUSION – WERBER, VERNE, AND NANTES

The first chapter analyzed how discourse and technology were related in that naturalists had access to more information thanks to the microscope, and yet, poetic discourse and imagination remained a part of these texts. The second chapter discussed how the new ways in which insects were perceived impacted taxonomical systems in the eighteenth century, and how these impacts can be linked to modern authors who inherited a complex understanding of insects. Finally, the third chapter argued that the smallness of insects urges any observer to think about the world in perspective, and how this concept that was at first mathematical transferred into philosophy and literature as a way to understand and place humankind in the world.

Perspective is a tool that is used to talk about insects and mankind, and is therefore part of the ‘technology’ of a literature, that is, a way to talk about the invisible and the unknown. Technology and fiction are then related in multiple levels, and I would like to end this thesis by expanding my research to an author who, throughout his life’s work, mastered the connection between science, technology, and literature, and foresaw in his novels some of the most important discoveries and technological progress of the twentieth century. This author who chose science as the engine for his imagination is none other than Jules Verne. In his time, Verne was a pioneer, a thinker of futures where technologies are more advanced and allow humankind to explore the world further and in unexpected ways.

The reasons why I decided to finish with an analysis on Verne are multiple, the first one being that Verne has always been an inspiration for Werber. Werber writes in his online biography that “A cette époque je me passionne surtout pour Jules Verne. L’Ile Mystérieuse me

semble le chef-d'oeuvre inégalable,” and multiple articles mention his interest for Verne.¹⁷⁹

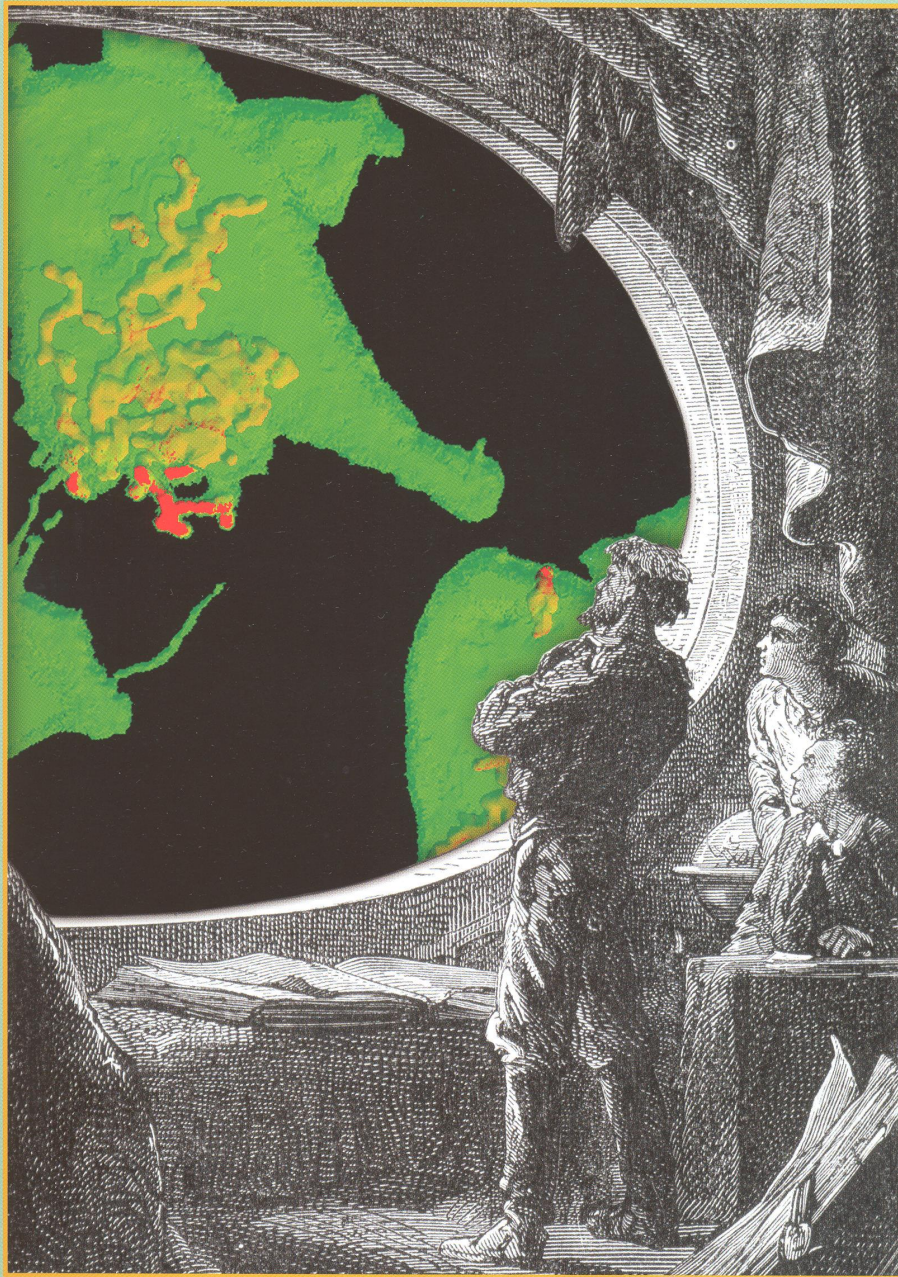
Because of this link between the two authors, Werber was asked by the Institut National de la Santé et de la Recherche Médicale (INSERM) to be the head speaker for the exposition *Science/Fiction, Voyage au Coeur du vivant*: “L’exposition [...] permet de montrer que la science n’est pas un univers froid et technologique mais un domaine qui ouvre à l’art, à l’imagination et à l’humour.”¹⁸⁰ The exposition featured seventy-four pictures that were the product of a transdisciplinary and trans-century collage. The works of art presented were a combination of engravings from the nineteenth century from one of Verne’s novels and of ultra-modern pictures taken by scientists through microscopes (figure 6). The juxtaposition of these two elements creates an image that links the technology available during Verne’s time to that of our modern world. Moreover, since Werber captioned these collages, this scientific exposition linked to technology also became a literary exposition, the key which finally united technology, science, and fiction.

¹⁷⁹ Werber, Bernard. “Biographie”. Site Officiel. Np. Web. 06 March 2018.

<http://www.bernardwerber.com/bio/biographie_plus.php> [At this time, I am fascinated mostly by Verne. His *Mysterious Island* seems to me like an unrivalled masterpiece]. For the other articles that mention the link between the two authors, see

<http://www.bernardwerber.com/interviews/LaCroix_Aout2003.html> “Lui qui grandit littérairement à travers Edgar Allan Poe et Jules Verne” [He, whose literary taste grew through Edgar Allan Poe and Jules Verne] lire or <<http://journalmetro.com/culture/587280/bernard-werber-le-bonheur-est-dans-la-creation/>> “Pour moi, les grands auteurs sont ceux qu’on dit populaires: Jules Verne, Edgar Poe, Stephen King” [To me, the great authors are those who are said to be popular: Jules Verne, Edgar Poe, Stephen King].

¹⁸⁰ Werber, Bernard, et al. *Science/Fiction voyage au coeur du vivant*. Chêne, 2011.



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Vingt mille lieues sous les mers, Jules Verne. Musée Jules Verne-Ville de Nantes

Figure 6: As a reminder from chapter one, Voltaire defined imagination not as a creative force, but as the ability to form images of objects in the real world in one's mind.: Werber, Bernard, et al. *Science/Fiction voyage au coeur du vivant*. Chêne, 2011. P.21.

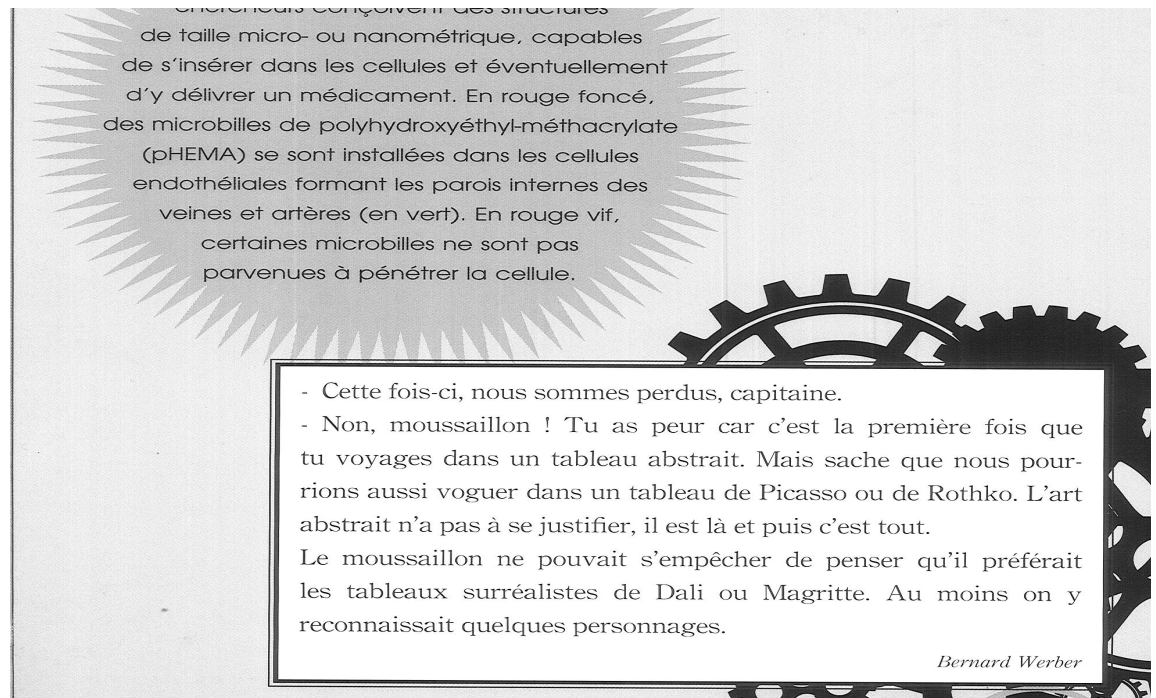


Figure 7: Werber, Bernard, et al. *Science/Fiction voyage au coeur du vivant*. Chêne, 2011. P.20.
 [To observe or identify living forms, researchers conceive micro or nanometric structures that are able to get inside cells and eventually, to depose in it a medication. In dark red, micro-marbles of polyhydroxyéthyl-méthacrylate (pHEMA) that are in endothelial cells that form the inner wall of veins and arteries (in green). In bright red, some micro-marbles have not been able to penetrate the cell.]
 [That's it, we are lost captain. No way cabin boy! You are scared because this is the first time that you travel inside an abstract piece of work. Know that we could travel in a Picasso or a Rothko. Abstract art does have to justify itself, it's there and that's it. The cabin boy couldn't prevent himself from thinking that he preferred surrealist pieces of work by Dali or Magritte. At least one could recognize some character in them.]

By combining scientific discourse and Bernard Werber's imaginary texts (figure 7), this exposition demonstrates that science, imagination, marvel, literature, and art share common threads that allow an interdisciplinary understanding of the order of the physical world. Far from a cold and rigid field, science is a world where imagination is vital. Discovering and trying to understand the unknown, it can only be done through one's imagination. Imagination allows for thought beyond known scientific facts, looking for answers and expanding knowledge.

The exposition *Science/Fiction voyage au coeur du vivant* was published as a book where the works of art are presented. André Syrota, director of the INSERM, prefaced the book by introducing Verne as an author interested in all forms of sciences, be they natural, social, or literary sciences. He also explained the importance that technology has on our modern ways of studying the natural world. This preface is followed by an “invitation au voyage” by Arnaud Benedetti, director of communication for the INSERM, in which he draws parallels between the scientific journey and the imaginary journey. To him, these two journeys are not antithetical, on the contrary, people should see them as symbiotic since “sans inspiration, pas de recherche ! Sans recherche, pas d’inspiration.”¹⁸¹ Research and fiction draw inspiration from one another, helping scientists to conquer the unknown, and helping artists to write or paint what is yet to be discovered. For instance, one could say that Verne’s imaginary voyage inside the yet-to-be-discovered abyss of the ocean allowed scientists to think about the possibility of traveling underneath the sea with submarines and diving suits. The unknown of the abyss allowed Verne to imagine a fictional world that inspired scientists to look for ways to make that *voyage extraordinaire* become true.

Werber wrote a cover note in in this volume in which he stated: “Jules Verne, pour moi, c’est l’initiateur. C’est celui qui m’a donné envie de voyager loin juste en ouvrant un livre et c’est aussi celui qui m’a appris que juste avec des mots, on peut faire exploser toutes les frontières.”¹⁸² Werber explained that as a science-philosophy-fiction writer, his goal is to “explorer les zones inconnues, c’est de prolonger le travail de Jules Verne. Jules Verne allait

¹⁸¹ Ibid., p.8.

¹⁸² Ibid., Flyleaf (n.p.)

sous l'eau et sur la lune, mais maintenant les enjeux de l'humanité sont différents.»¹⁸³ Werber therefore considers himself as a modern-day Verne who draws inspiration from science to write fiction. And yet, both authors use different methods to achieve their plans and to develop fictional arguments. Thanks to the creation of the internet, Werber was able to create his participative *Arbre des possibles* which allows him to explore the potential futures for humanity. He strives to be a maker of contemporary *voyages extraordinaires* using scientific discoveries and problems from his time – such as the research of the afterlife, the role of the author, matters of religion and spirituality– as did Verne back in the nineteenth century. As Benedetti said in his invitation, “Partant de Jules Verne, Bernard Werber et Eric Dehaussse composent un récit polyphonique où toute nouvelle correspondance ouvre la route vers de nouveaux mondes.”¹⁸⁴ Through this exposition, Werber re-reads Verne, re-enchanting him in the light of modern biology. The elements of the exposition create new roads to understand his works, new roads to interpretation, and new roads towards more imaginary worlds. Werber and Verne are similar in multiple ways, and the exposition Science/Fiction was a way to officially combine Verne and Werber's worlds and eras.

The second reason why I deliberately chose to conclude with the example of Jules Verne is because of the city in which he grew up, Nantes, which has paid tribute to the author in ways that resemble Werber's paradigms and the worlds he created in his novels. Nantes hosts the Jules Verne Museum in a three-story house that overlooks the Loire river, but the whole city has been seeking to capture the essence that Jules Verne left in his novels through two main urban development projects: the *Ile de Nantes* and *L'Arbre aux herons*. By integrating very

¹⁸³ RFI – Microméga - 3 septembre 2005 – Sur le souffle des Dieux [to explore the unknown zones, to extend Jules Verne's work. Jules Verne went under water and on the moon, but now, what is at stake for humanity is different.]

¹⁸⁴ Werber, *Science/Fiction*. P.8. [Using Jules Verne, Bernard Werber and Eric Dehaussse write a polyphonic story where each corresponding short story open the road toward new worlds.]

technological and futuristic features into the framework of the city, Nantes is bringing back to life a world that is worthy of Verne's trademark, that is, a world that embraces the idea of science, fiction, and technology for the better. In most of Verne's novels, science and technology are used to help people, from travelling around the globe to deep down in the abyss. In the heart of the city, which used to host the industrial harbor, Nantes is paying a tribute to Verne by transforming the landscape of the city in a technological way, combining mechanical technology with the technology of thought and language. There are multiple installations located in the *Ile de Nantes* that deserve recognition and study. The urban development project on the *Ile de Nantes* is "at the crossroads of Jules Verne's 'invented worlds,' the mechanical universe of Leonardo da Vinci, and of Nantes' industrial history."¹⁸⁵

As an example, the *Grand Elephant* is one of the city's main attractions. Coming right out of Verne's imagination in his novel *The Steam House* [*La Maison à vapeur*] in which he imagined a steam-powered mechanical elephant, the *Grand Elephant* made out of steel can host up to 50 passengers on board and wanders around the *Ile de la Cité*, trumpeting and sprinkling tourists and local inhabitants with water. Walking from the main building that hosts the *Galerie des Machines* to the *Carrousel des Mondes marins*, this massive technological steel-moving-animal hybrid can be seen from afar and represents what the city has to offer: a place where Jules Verne's legacy lives on at the heart of the city. Verne's literary tradition is brought to life through the technological animal, his imagination is rendered material and tangible. Instead of imagining machines on paper, here the world attempts to realize imagination.

¹⁸⁵ <<http://www.lesmachines-nantes.fr/en/machines-de-l-ile/the-prototype-branch/>>



Figure 8: Nantes' *Grand Elephant*

© <http://www.lesmachines-nantes.fr/en/machines-de-l-ile/the-grand-elephant/>

In the background of this picture stands the *Carrousel des Mondes Marins*. At the intersection of fairground and technology, this three-story carousel follows a progression from the abyss to the surface. One again originating in Verne's imagination, particularly in *20 000 Leagues under the Sea*, the *Carrousel* offers his visitors a new take on the sea, bringing into a material form Verne's novels. While these two attractions are already implemented in the city and help to understand the city's goal of paying a tribute to Verne's legacy, one project under construction will be the pinnacle of Nante's Vernian world. The city of Nantes signed a contract for a new urban project: *L'Arbre aux Hérons*. Transforming a deserted old quarry in the *Ile de Nantes* into a modern urban park that would take the shape of a tree, this new attraction will open to the public in 2020.

The tree will be made out of wood and steel, that it, it will be as natural as it will be industrial and man-made. The name, 'the herons' tree,' comes from the fact that two mechanical herons will overlook the tree, and will allow visitors to board them in order to fly over it. People will literally take on the perspective of a bird that looks down on the tree, the Loire river, and the

city of Nantes. Here is a picture of one of the herons as it is showcased in the *Galerie des Machines*:



Figure 9: The Heron in the *Galerie des Machines*

The *Arbre aux Hérons* will host a plethora of animals, and while engineers are still doing research on which animals are going to be showcased within the tree, some already exist and are also exhibited in the *Galerie des Machines*. The “Chenille arpenteuse” [striding caterpillar] (figure 11) will go from one branch of the tree to another, while the Spider (figure 12) will be lifted from the ground to one of the highest branches, and the trunk will be teeming with Ants (figure 13) (*fourmiller de fourmis*), among other insects.



Figure 10: The Caterpillar in
the *Galerie des Machines*



Figure 11: The Spider in the
Galerie des Machines



Figure 12: The Ant
in the *Galerie des
Machines*

A leaflet describes the future tree as such:

L'Arbre est en acier, mesure 50 m de diamètre et culmine à 30 m. (...) Les 22 branches de l'Arbre ont une longueur développée de plus d'un kilomètre, dont 500 mètres accessibles au public. Le végétal s'enracine dans l'acier et le public a accès à d'incroyables jardins qu'il découvre de branche en branche comme dans une succession de terrasses suspendues reliées entre elles. Cette Cité dans le ciel abrite tout un bestiaire d'animaux.¹⁸⁶

With its imposing, that tree will allow visitors to walk freely in a mechanical, yet natural, garden. Just as Réaumur, Michelet, Verne, and Werber did in the past, Nante's future tree will approach the natural world from an interdisciplinary angle, mixing the natural and the techno-scientific to create a sort of marvelous realm where insects become a source of entertainment, yet also a source of scientific inquiry. By creating human-size insects, visitors will have the impression that

¹⁸⁶ The steel tree is 30 meters high and has a diameter of 50 meters. Its 22 branches cover more than one kilometer, 500 meters of which are open to the public. Plant are rooted in steel, and the public has access to incredible gardens from one branch to another one, as in a succession of linked suspended patios. This City in the sky houses an entire bestiary of animals.

they were themselves reduced to a smaller size. Just as Alice entering Wonderland, the visitors will enter a sort of ‘Insectland’ where the marvelous and the fictional become reality.

The leaflet describes the tree as a “Cité dans le ciel,” [City in the sky]—as if entering this tree meant leaving the city of Nantes to encounter another realm, a realm of marvelous and fiction where insects are no longer ‘simple’ insects. They are the result of technology, science, and engineering, meaning that they do not exactly fit in the common definition of ‘insects.’ The definition of insect is once again rendered blurry by this tree, where insects are as large as humans, making their size almost threatening. Over the course of the eighteenth century, technology helped naturalists obtain a better understanding of the world, and yet being able to see more made their preconceived ideas and definitions about insects obsolete. In 2020, through the use of technology to create hybrid insects, this tree will also change people’s ideas about their relationship to insects, challenging current definitions and taxonomies. Moreover, these insects will also challenge people’s relationship to the environment and to the natural world, making them more aware of the teeming lives of the world through bigger, more visible versions of them.

In a word, this tree will be a material representation of Réaumur’s *merveilleux vrai*, as a material world of marvelous fiction in the city of Nantes. By playing with the idea of perspective to create a different realm with “intraterrestrial inhabitants,”¹⁸⁷ the tree will leave its curious visitors puzzled. “What actually *is* an insect? What relationship do they have with us, human, as well as with the whole greater natural world? How does the fact that these technological insects are more imposing than mine impact my perception of them?” are some of the questions that visitors might have as they exit the future tree, questions I approached in each part of this

¹⁸⁷ Werber, *Les Fourmis*, 281-282. (See footnote 69).

project. And, thank to Nante's tree, it may well be that a French speaking 59-foot ant with a hat on its head...might exist.

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